Descriptions of Remedial Options for Addressing Asbestos-Containing Cementous Materials

Johns Manville International
Marrero, Louisiana

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Job No. 6032-09

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1.0 INTRODUCTION

1.1 INTRODUCTION

ERM EnviroClean-Southwest, LLC (ERM) is pleased to provide on behalf of Johns Manville International a summary description of alternative options for remediation of asbestos-containing cementous material (ACM) from residential and school properties on the Westbank of the Mississippi River in the Marrero, Louisiana area. The report will focus on options for remediation of driveways, sidewalks, playgrounds, and schoolyards constructed of ACM. However, EPA has indicated that the remaining ACM used for garage floors or beneath homes may be addressed in future remedial activities. Thus, the identified technologies have also been considered for these potential future remedial activities.

1.2 BACKGROUND

The area is very flat, is subject to heavy rains, and is characterized by poor drainage. Many residents, the parish, and schools in the Marrero, Louisiana area may have used ACM materials to construct driveways, sidewalks, playgrounds, patios, garage floors, and for surfacing the ground beneath houses. Because the local soils have poor bearing capacity, many of these features, especially driveways have settled and cracked. As a result of the landowners' pouring additional ACM, many of the driveways are now over one foot thick.

In October 1996, EPA commenced a time-critical removal action pursuant to CERCLA at the Westbank site located in Jefferson and Orleans Parishes. The action EPA proposed to be undertaken was to prevent, limit, or mitigate a perceived emergency situation at the site created as a result of asbestos-containing materials (ACM) that had long been present at the site and which were perceived by EPA to be deteriorating and becoming friable. EPA Region VI stated in its memorandum to EPA headquarters requesting approval of a time critical removal that there was an immediate risk to public health or welfare or the environment in that rapid deterioration of ACM may increase likelihood of transmission and exposure.

2.0 *GENERAL TECHNICAL APPROACH*

For the purposes of the report, it has been assumed that some remedial action (i.e., encapsulation or removal) is necessary at the varying ACM locations. EPA's stated objective of the remedial action is to prevent potential exposure of residents and the public to unacceptable levels of airborne ACM, and to reduce significantly the likelihood of future releases. Accordingly, readily available technologies have been identified to mitigate potential exposure by either removal or encapsulation. In identifying suitable alternatives, ERM considered the following:

- Whether the technology is generally available and well known (not experimental);
- The alternative can be implemented as fast or faster than the EPA's removal alternative;
- Ability for the technology to achieve remediation goals and objectives;
- Whether the technology has a proven track record;
- Suitable for New Orleans area (soils, climate, elevation, drainage, etc.);
- Whether the technology has a useful life similar to that of conventional reinforced concrete in New Orleans; and
- Whether the cost is less than or equal to EPA's removal alternatives.

3.0 *DESCRIPTION OF REMEDIAL ALTERNATIVES*

3.1 TECHNICAL APPROACH FOR IDENTIFYING OPTIONS

The purpose of this section of the report is to identify cost-effective alternatives which are readily available for addressing potential release of asbestos fibers from concrete sidewalks and driving surfaces composed of concrete reinforced with asbestos in the Marrero, Louisiana area. Several viable remedial alternatives that were identified are effective and protective of human health and, vary in performance, ease in applying, time to install, risk of asbestos release and cost.

Several alternative technologies to removal were identified based upon the following readily available sources:

- Free trade journals (such as *Roads and Bridges*),
- Library references that are available on the Internet,
- Residential mailers (such as the marketing mailers for Perma Crete™ concrete overlays),
- Technologies were identified from ERM's civil construction experience, and
- Telephone contacts with Louisiana State University civil engineering professors.

Based on a non-exhaustive study, at least two viable alternative remedial approaches to removal exist. These entail containing the ACM in place with the use of:

- An asphaltic overlay, and
- A concrete overlay or a protective coating that is resistant to wear. For each of these three approaches, multiple options can be identified. For example, different types of asphaltic mixes, cement mixes and protective coatings have been developed by the road and pavement industry and have been used effectively as road surfaces in heavy traffic areas.

3.2 Summary of Options

In accordance with the National Contingency Plan, ERM performed a screening of available technologies and potential response actions. Under the Section 104 regulations found at 40 CFR 300.415(d), capping and containment are appropriate options. Therefore, these were considered in addition to the removal option EPA implemented. The following options were identified:

- Removal and replacement with a conventional, reinforced-concrete slab;
- Asphalt overlays;
- Concrete overlays, including a conventional concrete overlay, a concrete overlay containing "Fibermesh" and a specialty acrylic polymer-modified concrete overlay; and
- Protective coatings, such as Tech Cote, Polibrid 705, PermaTec 3000 and FEC-2233 coatings.

A general description of each of these options is included in Table 1, and a more detailed discussion is provided in the following subsections. Additional information on each is provided in the Appendices.

3.3 *DESCRIPTION OF REMEDIAL TECHNOLOGIES*

3.3.1 *Removal and Replacement with Conventional Reinforced-Concrete Slab*

The removal and replacement of the concrete, involves first excavating the ACM and then replacing it with a conventional, reinforced-concrete slab. It was assumed that the underlying soil would be prepared via liming and compaction to form a stable base for the concrete. The thickness of the ACM varies from property to property. In situations where the material is greater than 3 to 5 inches, backfill will be placed into the excavation and prepared before the concrete is poured.

For evaluation purposes, the removal and replacement option will be compared with alternative options. The installation time of replacement concrete slabs will vary because of the varying thicknesses of the ACM. Once the concrete is poured, it requires 1 day to cure for foot traffic and at least seven days to cure before it is accessible to vehicular traffic, and about 28 days to cure fully. It was assumed that the concrete slab will be installed to the same grade as the previous surface; therefore, no significant change in drainage should occur.

3.3.2 *Asphalt Overlay*

An asphalt overlay is the most common method in the pavement industry for protecting existing concrete pavement which has begun to crack or crumble. In the past, conventional asphalt overlays have been prone to fail as a result of poor bonding and cracking. In recent years, advanced asphaltic overlays with greater durability have been developed. The "Stylink" asphalt overlay system was selected as representative of viable asphalt overlay systems. Use of the

TABLE 1

Description of Remediation Options

Asbestos-Containing Cementous Material
Marrero, Louisiana

Options	Description
Removal and Replacement:	Removal of the asbestos-containing cementous material and replacement with a conventional reinforced concrete slab to the grade of the previous surface.
Advanced Asphalt Overlays	Polymer-modified binder coupled with a quality aggregate producing a 1/4-inch overlay.
Concrete Overlays:	
Conventional Concrete Overlay	Conventional concrete overlay with welded-wire reinforcement producing a 2-inch overlay.
Concrete Overlay with "Fibermesh"[1]	Polypropylene fiber reinforced concrete producing a 2-inch overlay.
Acrylic Polymer Modified Concrete Overlay (Perma Crete)	Concrete resurfacing acrylic polymer cement compound producing a 1/8-inch overlay.
Protective Coatings:	
Tech Cote[2]	Concrete resurfacing polymer resin producing a 1/8-inch thick coating.
Polibrid 705	Solventless elastomeric polyurethane aromatic chemical cure producing a coating 150-microns thick.
PermaTec 3000 "Industrial Coating"[3]	Concrete resurfacing epoxy with silica filler to provide non slip surface producing a coating 1/8-inch thick.
FEC-2233	Epoxy modified with liquid polysulfide producing a coating 40-mils thick.

NOTES:

1) "Fibermesh", a registered trademark of Synthetic Industries, Inc., has been used with good long-term durability as intersection overlays for concrete constructed on coastal, marsh soils with, is poor subbase characteristics. It is the overlay method of choice for several coastal communities.
2) Tech Cote has been used successfully to overlay asbestos-reinforced concrete in the City of Palmdale, California.
3) PermaTec 3000 has been used successfully to encapsulate concrete containing PCB's.

"Stylink" polymer-modified asphalt mix entails surface preparation, application of a tack coat, and pouring a ¼-inch thick, polymer-modified, hot-mix asphaltic concrete. The overlay can be completed, as described in *Roads and Bridges*, v. 35, No. 12, December 1997, to have a final thickness of approximately ¼ inch, including the tack coat. Surface preparation involves the removal of loose material and the surface must be allowed to dry. A polymerized asphalt emulsion tack coat is then applied to bond the asphaltic concrete to the underlying surface. Finally, the polymer-modified asphalt mix is applied and compacted. Installation can be completed within approximately two days and the driveway will be accessible within one day of completion. Drainage changes are unlikely because of the thin thickness of the overlay or protective coating alternatives; where drainage changes can occur, they can be addressed via minor drainage improvements. Asphalt overlays can be applied using smaller equipment for garage floors but they are not practical for under homes.

3.3.3 Conventional Concrete Overlay

The conventional concrete overlay includes a conventional, cast-in-place concrete slab on grade with welded-wire reinforcement. Surface preparation involves removing loose material. The overlay can be placed using standard concrete pouring techniques and will have a thickness of approximately 2 inches when completed. The concrete will require at least seven days to cure before it is accessible to vehicular traffic; however, foot traffic can be allowed within one day of completion. Conventional concrete overlays can be used for garage floors but, to be used to address ACM under homes, they require placement of welded-wire reinforcement by hand under homes.

3.3.4 Concrete Overlay Containing Fibermesh

Fiber-reinforced concrete overlays have been shown to be more resistant to cracking and failure where poor subbases exist. This overlay system has become especially popular for intersections and old pavements with heavy traffic. The Synthetic Industries Fibermesh-reinforced concrete system was selected as representative of fiber-reinforced concrete overlays. Use of the Synthetic Industries "Fibermesh" polymer fiber-reinforced concrete overlay entails a polymer reinforcement instead of a welded-wire or rebar reinforcement. The reinforcement is placed in an otherwise conventional concrete mixture and installed as a cast in-place slab (approximately 2-inches thick) on grade. Surface preparation involves removing loose material and (like standard concrete) will require approximately seven days to cure before vehicular use should be allowed. Fibermesh concrete can also be poured readily as an overlay for garage floors and ACM under homes.

3.3.5 *Acrylic Polymer Modified Concrete Overlay*

Acrylic polymer modified concrete has increased in popularity for special overlay applications where a high strength overlay is desired for cracked sidewalks, driveways, or pavement. Its popularity has increased in part because the surface can be imprinted to appear like brick or tiles. The Quality Systems "Perma Crete™" overlay system was selected to be representative of an acrylic polymer-modified concrete overlay.

Installation of Perma Crete requires surface preparation, placement of non-reinforced modified cement, and curing of the overlay. Surface preparation involves removal of loose material. Cracks can be filled with "Matrix Mix"-like filler prior to applying the surfacing. The polymer-modified concrete is then installed and allowed to cure. Curing requires 24 hours to complete, and the driveway is accessible within 3 days of application. Perma Crete can also be poured readily as an overlay for garage floors and ACM under homes.

3.3.6 *Tech Cote Coating*

The Tech Cote Polymer Systems "Tech Cote Polymer Resin" is a polymer-modified cement grout coating. Installation includes surface preparation and application of a single top coat of polymer-modified cement grout (approximately ⅛ inch). An optional grout base coat and water sealant can also be used. Surface preparation involves removal of grease and loose material or scrubbing with an acid etch and rinse. Cracks can be filled with an epoxy filler to inhibit chipping. Installation requires about two days, and the driveway is accessible within one day of completion. Tech Cote coatings can also be applied readily to garage floors and, using modified spray equipment, under homes.

3.3.7 *Polibrid 705 Coating*

The Polibrid Coatings "Polibrid 705" is a polyurethane aromatic thermosetting coating. Installation includes surface preparation, application of a prime coat to seal the existing surface, and an airless-spray or roller brush application of the top coat. The coating will have an approximate thickness of 150 microns and will not significantly increase the elevation of the existing driveway. Surface preparation involves removal of grease, dirt, and loose material or scrubbing with an acid etch and rinse. Preparing the surface should create a surface texture resembling coarse sandpaper. Cracks and voids must be filled with epoxy filler to prevent chipping. Standing water and visible moisture must also be removed. The prepared surface is then primed with "Polibrid 670-S". A

top coat of Polibrid 705 is applied immediately after the prime coat, which may still be damp to the touch. The driveway will be accessible to foot traffic within two hours and vehicular traffic within 24 hours. Polibrid 705 can be applied to garage floors; however, because of the dampness under homes and surface preparation requirements for a thermosetting coating, Polibrid 705 is less suitable for use under homes.

3.3.8 PermaTec 3000 Coating

The Chemproof Polymers "PermaTec 3000 Industrial Coating" is a silica-modified, epoxy non-slip coating. Installation includes surface preparation, trowel application of the coating (approximately ⅛ inch), and broadcast application of a silica-sand surface finish to the leveled surface. Surface preparation involves removal of grease, dirt and loose concrete or acid etching and rinsing. Cracks can be filled with epoxy joint filler to inhibit chipping, and standing water should be removed prior to application. The coating is then applied with a trowel. The surface temperature should be between 65° and 90°F. A silica surfacing is added for skid resistance after leveling. Because of the requirements for eliminating dampness and surface preparation, PermaTec 3000 is less suitable for use under homes.

3.3.9 FEC-2233 Coating

The Morton International "Thiokol FEC-2233/LP" polysulfide-modified, epoxy coating includes surface preparation, spray, roller, or squeegee application of coating, and broadcast applications of a silica sand surface finish to the leveled surface. Surface preparation involves the removal of grease, dirt and loose concrete or acid etching and rinsing. A heavy brush can be used to roughen smooth surfaces. This probably would be unnecessary for the existing driveway surfaces. Cracks should be filled with joint filler, dampness and standing water should be removed, and the surface should be allowed to dry if damp. Cleaning is completed by vacuuming. Silica surfacing is added for skid resistance after leveling. The final thickness of the coating will be approximately 40 mils. Installation will require approximately two days to complete, and the driveway will be accessible within one day of completion. Because of the surface preparation and application requirements, FEC-2233 is less suitable for use under homes.

4.0 *PREVIOUS APPLICATIONS OF REMEDIAL TECHNOLOGIES*

Upon identification of remedial alternatives, contact was made with manufacturers, vendors, and the City of Corpus Christi, Texas public works department. The City of Corpus Christi has used both conventional reinforced concrete and "fibermesh" reinforced concrete in the construction of roadways. The Corpus Christi area has soft soil with a high shrink/swell potential similar to the soils of New Orleans. Mr. Joe Trejo of the Public Works department explained that "fibermesh" reinforced concrete has been used with great success on busy intersections where conventional concrete has failed. Upon Mr. Trejo's reference, Ralph Robinson of Fibermesh was contacted. Mr. Robinson supplied a list of Fibermesh projects that have been completed in the south and also provided case studies. One case study in particular involves the New Orleans Regional Transit Authority Bus Maintenance Facility (Appendix C). Fibermesh concrete was chosen to increase lasting performance of the concrete at the maintenance facility and used to surface a 70,000 square foot garage and 22,000 square foot administration building. According to Fibermesh marketing materials, "fibermesh" concrete was also used at the Denver International Airport.

John Trice, the Regional Manager of TechCote Polymer Systems was also contacted to discuss prior applications of TechCote. Mr. Trice explained that TechCote had been utilized by the City of Palmdale, California to encapsulate asbestos containing concrete. According to manufacturer supplied information, the coating is capable of encapsulation because it increases the compressive strength of conventional concrete by 200% and tensile and flexural strength by 300%.

PermaTec 3000 by ChemProof Polymers Incorporated has been utilized for encapsulation of PCB containing concrete according to Gene Schisel, product representative. Based on discussions and correspondence with Mr. Schisel, the product has been used in several locations in the U.S. with favorable results.

Trade magazines were also used to research applications of these options. *Roads and Bridges*, December 1997 had an article discussing the use of an advanced asphalt overlay in Freeport, Illinois. A polymer-modified asphalt mix was used to overlay aging streets. After approximately 1½ years, none of the sections shows any significant signs of cracking (Appendix A).

PermaCrete, FEC-2233, and Polibrid 705 have all been used successfully in various projects. PermaCrete was used to resurface the Allegheny Center in Pittsburgh, Pennsylvania, saving thousands of dollars in maintenance costs.

Appendix A contains correspondence from David M. Knight documenting this work. FEC-2233 and Polibrid 705 have both been utilized in industrial facilities for liner and containment systems. Table 2 summarizes the previous uses of each of the identified technologies. Table 3 summarizes the results of a non-cost elevation of performance for each of the identified technologies.

According to the results of the non-cost evaluation, three options are preferred, the concrete overlay containing Fibermesh, a polymer modified concrete such as Perma Crete, and a polymer resin-modified cement coating such as Tech Cote.

The overlay or coating options satisfy the CERCLA criteria for remedy selection. According to 40 CFR 300.415 (b)(1) "the lead agency may take any appropriate removal action to abate, prevent, minimize, stabilize, mitigate, or eliminate the release or the threat of release" provided the eight factors listed in 40 CFR 300.415 (b)(2)(i through viii) are evaluated. The following is a discussion of these factors regarding how containment satisfy CERCLA criteria.

(i) The three types of remedial options - removal, overlays or coatings - are equally protective. Despite the presence of the ACM material on Marrero properties for 40 to 50 years, asbestos has not been observed in the air as friable particles above levels of concern, including when disturbed by EPA's contractors during removal. Asbestos has long been accepted as presenting no significant risk to human health and the environment if the asbestos present in ceiling or floor tiles indoors or contained in walls or beneath floors in mastic or elsewhere did not noticeably release fibers except when abraded or disturbed. Because all of the ACM was not always removed from the driveways and sidewalks and it is impractical to remove the ACM from garage floors or under homes, EPA's removal option as implemented is comparable to the concrete overlay options on protective coatings. All three are effective protection against exposure to friable fibers from the underlying ACM.

(ii) The ACM and the risk of contamination to drinking water or sensitive ecosystems is not an issue. The ACM is not leachable and is not likely to migrate into the ground water or nearby bodies of surface water.

(iii) The asbestos is not stored in bulk storage containers such as drums, thus a release from such containers is not relevant to the selection of a remedial alternative.

TABLE 2

Examples of Previous Applications of Remediation Options

Asbestos-Containing Cementous Material
Marrero, Louisiana

Options	Applications
Removal and Replacement	EPA partially removed asbestos-containing cementous material and replaced it with conventional reinforced concrete in Marrero, Louisiana.
Advanced Asphalt Overlays	Civil Constructors, Inc. installed the proposed type of advanced asphalt overlay to residential streets in Freeport, Illinois; to date no significant signs of cracks are evident.
Concrete Overlays:	
Conventional Concrete Overlay	City of Corpus Christi, Texas has used conventional concrete overlays on streets with some success.
Concrete Overlay with "Fibermesh"	City of Corpus Christi and Houston, Texas have installed Fibermesh-reinforced concrete overlays to busy intersections to reduce maintenance cost with great success.
Perma Crete	Allegheny Center Plaza in Pittsburgh, Pennsylvania resurfaced the plaza and saved thousands of dollars in repair and maintenance costs.
Protective Coatings:	
Tech Cote	City of Palmdale, California used the material with success to encapsulate asbestos-containing concrete.
Polibrid 705	This coating has been used by industry to line concrete in municipal wastewater systems and in secondary containment structures.
PermaTec 3000 "Industrial Coating"	This coating has been used successfully to encapsulate concrete-containing PCBs.
FEC-2233	This coating has been used by industry to protect steel and concrete on containment dikes.

Sources for the above information are readily available information in trade journals or at public libraries.

TABLE 3

Non-Cost Evaluation of Remediation Options
Driveways, Sidewalks, Garages, Under Homes

Options	Effectiveness	Implementability	Permanence	Traffic Rating		Total Rating	Ranking
				Foot	Vehicular		
Removal and Replacement	5	1	2	5	3	**16**	Undesirable
Advanced Asphalt Overlays	4	2	4	4	2	**16**	Less Preferred
Concrete Overlays:							
Conventional Concrete Overlay	4	4	5	5	3	**21**	Less Preferred
Concrete Overlay with "Fibermesh"	5	5	5	5	4	**24**	Recommended
Perma Crete	5	5	5	5	4	**24**	Preferred
Protective Coatings:							
Tech Cote	5	4	5	5	4	**23**	Preferred
Polibrid 705	5	3	4	4	2	**18**	Undesirable
PermaTec 3000 "Industrial Coating"	5	2	5	5	3	**20**	Undesirable
FEC-2233	5	2	3	3	2	**15**	Undesirable

(iv) Asbestos is a naturally-occurring mineral that is not leachable; therefore it is not considered to be mobile in the subsurface and will not migrate as a dissolved constituent.

(v) Weather conditions will not cause the asbestos to migrate or be released because the asbestos can be encapsulated effectively via an overlay or coating.

(vi) There is no threat of fire or explosion due to the presence of asbestos in the driveways.

(vii) There are other appropriate federal or state response mechanisms available to respond to this situation. Capping and containment of the ACM by the Parish, school authorities and local contractors are options that should be evaluated.

(viii) No other situations or factors that pose threats to human health and the environment have been identified in this case.

Upon evaluation of these engineering factors, it is concluded from the available information that EPA's goal of addressing the alleged risks from the ACM in driveways, sidewalks, garages and under homes can be addressed effectively via the use of overlays or protective coatings to cap and contain the ACM.

5.0 *COST COMPARISON OF REMEDIAL OPTIONS*

A completed cost for each of the remedial options has been estimated to facilitate a cost comparison. For cost estimating purposes, remediation (removal or encapsulation) of 1,000 driveways has been assumed as the scope of work. Each driveway is assumed to be 12 ft. x 30 ft. For 20% of these, it has been assumed that a gravel drain with perforated pipe will be constructed along the driveway to address potential drainage issues. Cost estimates are based on unit cost quotes provided by qualified vendors and civil construction industry-accepted cost estimating procedures. A summary of estimated probable costs for each technology is provided in Table 4. A comparison schedule for the remediation of 1000 driveways has also been developed based on vendor quotes and industry-accepted assumptions. The comparison schedule is provided in Figure 1.

Table 4

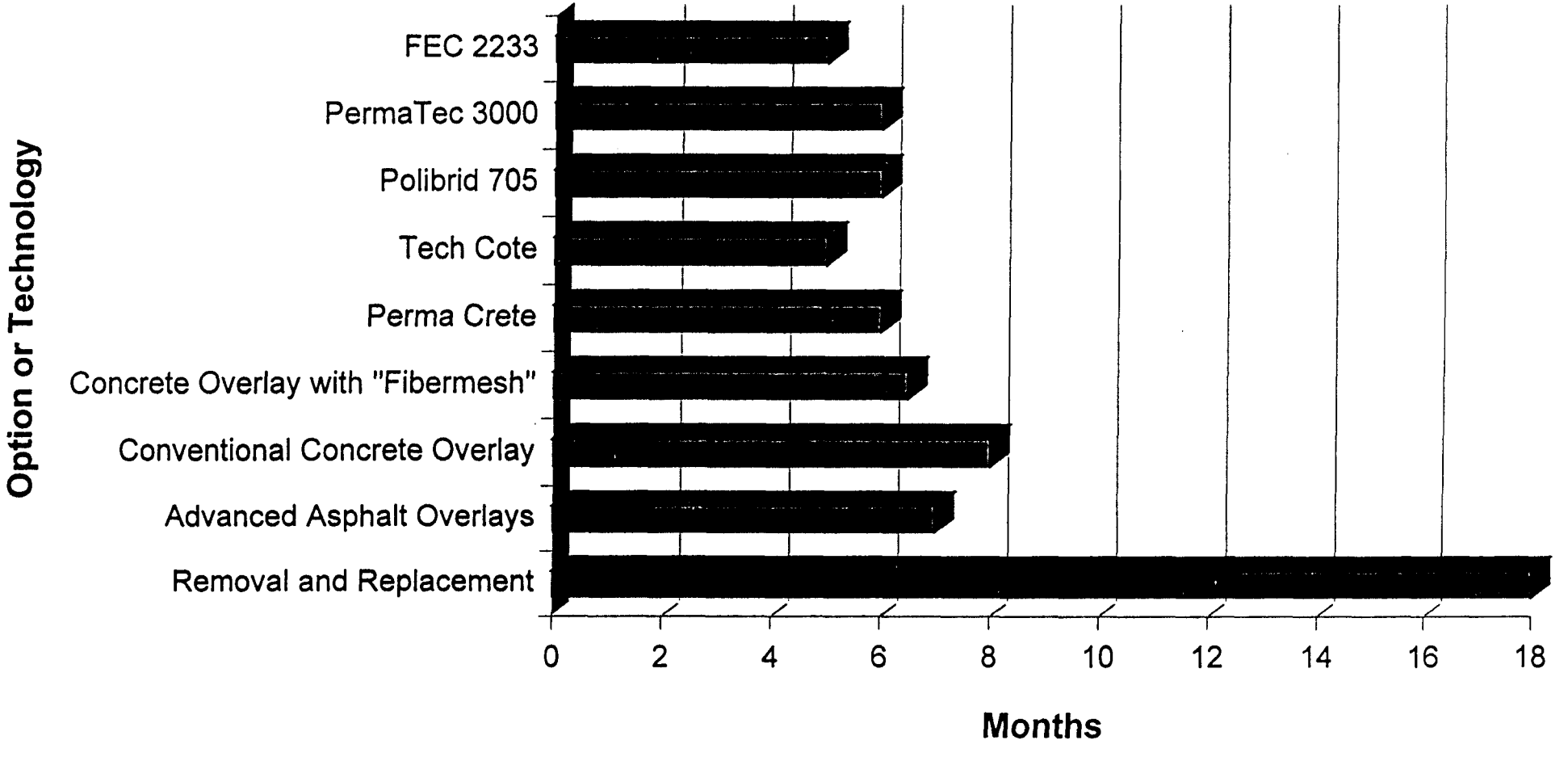
Cost Comparison of Remediation Options (1,000 Driveways)[1]

Options	Unit Material Cost (per sq ft)	Material Cost [2]	Const'n Cost	Transportation and Disposal Cost [3]	Replacement Cost [5]	Total Cost
Removal and Replacement	?	?	?	?	?	$24,000,000 ± [6]
Advanced Asphalt Overlays	$2.50	$900,000	$3,834,000	$80,000	$2,050,000	$6,864,000
Concrete Overlays: [4]						
• Conventional Concrete	$0.96	$130,000	$902,000	$80,000	$202,000	$1,314,000
• "Fibermesh" overlay	$1.07	$145,000	$949,000	$80,000	$214,000	$1,388,000
• Perma Crete	$3.00	$1,080,000	$681,000	$80,000	$191,000	$2,032,000
Protective Coatings: [4]						
• Tech Cote	$0.90	$324,000	$2,650,000	$80,000	$1,300,000	$4,354,000
• Polibrid 705	$5.00	$9,000,000	$6,220,000	$80,000	$11,440,000	$26,740,000
• PermaTec 3000	$1.71	$620,000	$4,811,000	$80,000	$1,007,000	$6,518,000
• FEC-2233	$1.00	$360,000	$2,912,000	$80,000	$2,122,000	$5,474,000

NOTES:

1) For cost comparison purposes, we have assumed a completed cost for removal and replacement of greater than $20 million based upon verbal communications with EPA's Contractors. Assuming a replacement slab thickness of 8 inches, the completed cost for replacement slabs is about $4,000,000. The balance of the cost, about $20 million, if associated with removal, transportation and disposal.
2) We assumed 1,000 driveways at 12' × 30'; for replacement concrete slab we assumed a thickness of 4", for concrete overlay we assumed a thickness of 2", for asphalt 1/4", and the manufacturers suggested thicknesses for coatings.
3) This cost for disposal of loose ACM debris for the overlay and coating "capping and containment" options is negligible in comparison to the material and installation costs. Disposal cost is based on an assumed average disposal volume of about 0.5 cubic yards of loose material per property (one half inch on a 12' x 30' driveway) and a unit transportation and disposal cost of $20 per cubic yard.
4) Where installed cost not provided, we applied a factor of 2.5 to the material cost to estimate the installed cost for concrete/asphalt overlays and a factor of 5.0 to estimate the installed cost for coatings.
5) For a worst case evaluation of maintenance costs, we assumed total replacement at the end of the useful life (without maintenance). The replacement cost (equal to the original construction cost) was adjusted to present value using a discount rate of 12%.
6) See Note 1; ERM could not reproduce EPA's projection of its cost because insufficient information on EPA's costs was available.

Remediation Schedule
Asbestos-Containing Cementous Material
Marrero, Louisiana



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Appendix A

Trade Information For Remedial Options For Addressing Asbestos-Containing Cementous Materials

Johns Manville International
Marrero, Louisiana

April 21, 1998
Job No. 6032-09

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Advanced Asphalt Overlays

Appendix A-1

Johns Manville International
Marrero, Louisiana

April 21, 1998
Job No. 6032-09

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Left: *Experience has shown that dense-graded mixes with in-place air voids greater than 8% are likely to disintegrate and fatigue more quickly.*
Below: *Improvements made by Superpave design methods are more durable, but only if they are properly compacted.*

A material engineer's perspective: Field compaction of Superpave mixtures

Superpave has made many improvements to the durability of asphalt cement concrete pavements, however, as with any new system, allowances must be made for the unexpected changes

by Michael K. Prather

Prather was formerly with the Indiana DOT during its SHRP Superpave mixture and binder testing. He is currently the materials engineer for Koch Material Co., Terre Haute, Ind.

There has been much discussion recently about mixture tenderness with some Superpave mixtures during field compaction. These mixtures appeared tender during placement even though they conformed to requirements, meeting $N_{initial}$ and not passing through the restricted zone. The tenderness is normally noticed as the rollers move on the hot mat in the mid range of cooling temperatures, 240°F to 190°F.

While some projects using Superpave mixtures with Performance Graded (PG) binders like PG 64-28, PG 64-34 and PG 58-40 have exhibited this problem, other projects with the same binder grades used, for example by the Utah and Colorado DOTs, have been successfully placed and are performing well. Why the difference?

Field compaction

Field compaction is one of the most important processes in asphalt pavement construction. Achieving proper compaction density is critical to the ultimate performance of the pavement. According to the *Asphalt Handbook, MS-4*, published by the Asphalt Institute, dense-graded mixes with good in-place air voids (6-8%) reduce the detrimental effects of air and water, especially raveling and stripping. Experience has shown that dense graded mixes with in-place air voids greater than 8% are likely to disintegrate and fatigue more quickly.

What does compaction achieve? During compaction, the hot-mix asphalt (HMA) mixture is compressed and reduced in volume via lubrication provided primarily by the asphalt binder.

The process increases the aggregate interlock, the interparticle friction and the density while reducing the HMA mixture's air void content.

There are five basic factors influencing HMA field compaction: 1) physical properties of the HMA component materials; 2) mat thickness; 3) environmental conditions at the time of compaction; 4) support of underlying materials including the subbase; and 5) type of compaction equipment and roller pattern used during construction. All of these factors are critical to the compactive effort. While the coarse-graded Superpave mixtures and the mat thicknesses may be even more important to compaction, this discussion will focus only on the physical components: asphalt binder, aggregates and moisture.

Most of our asphalt pavements have been constructed using a limited range of viscosity-graded asphalts, primarily AC-10, AC-20 and AC-30. Years of field experience with these asphalts have led us to believe that compaction needs to be achieved before the mix cools to 175°F. At this temperature, the mixture's internal friction and cohesion increases sufficiently so further compaction produces minimal additional density. Why, then, do the PG asphalt binders exhibit the mixture tenderness when viscosity-graded asphalts did not?

PG asphalt binders

Performance-graded asphalt binders may or may not be equivalent to viscosity-graded asphalts. Where there is not a great difference between the high and low PG temperatures, straight-run asphalts meet the specifications, and will exhibit the same behavior as their equivalent viscosity and penetration-graded asphalts. For the more severe grades modification is necessary.

Modifiers can significantly change the physical properties of the binder. PG binders are formulated to meet the specified high, intermediate and low temperature properties for the project's environmental and traffic conditions. Viscosity-graded asphalts are specified primarily by their viscosity at high temperature. Two different AC-20s may have the same viscosity at 140°F, but very different low-temperature properties. AC-20s from different sources currently on the market have been graded as PG 64-16, PG 64-22 and PG 64-28.

Typically, a grade with a wider temperature range, such as PG 64-34, is formulated by first choosing a base asphalt (such as an AC 2.5) conforming to the low-temperature stiffness and m-value requirements, as tested using the bending beam rheometer specified in AASHTO's MP-1.

In practice, the m-value generally needs to be higher than the minimum 0.300 to allow for variations in testing. Although there are wide variations in crude sources, normally a straight-run AC-2.5 or a premium AC-5 meets the -34 requirements. A conventional unmodified AC-2.5 should meet PG 46-34, and very high quality AC-5s may meet PG 52-34.

Once the base is selected, it is then modified to increase its temperature range and stiffen the high-temperature properties sufficiently to meet the specification as measured by the dynamic oscillatory shear rheometer. To do this, manufacturers may choose one of several methods, including polymer modification, air oxidation and chemical modification. In our example, the PG 46-34 can become a PG 64-34 with modification.

Temperature selection

In conventional mixtures, the optimal compaction temperature is determined by the asphalt binder's high temperature viscosity. It has been generally assumed that the same holds true for Superpave mixtures; that is, that the compaction temperature should be determined by the binder's stiffness at high temperature.

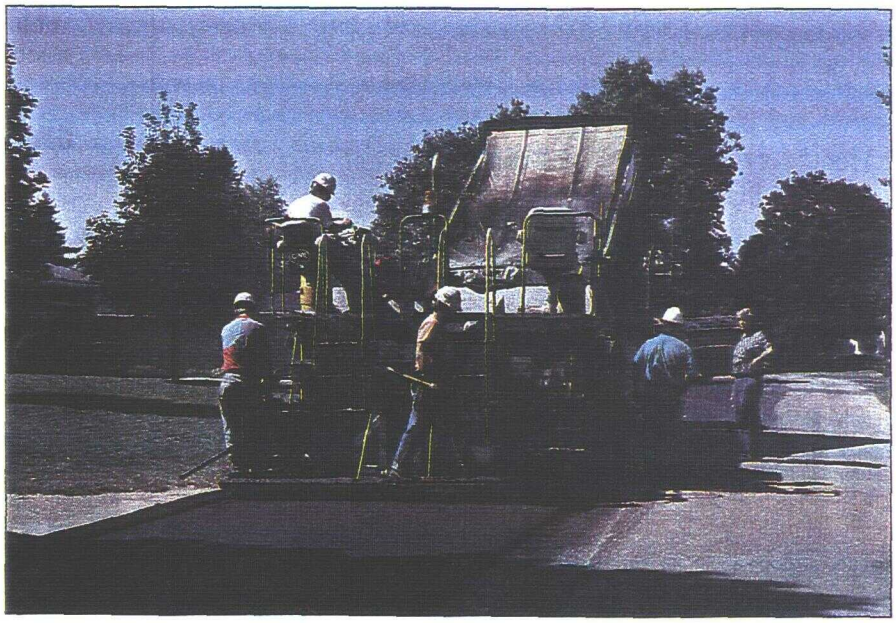
Because of the differing rheologies imparted by different types of modification, this may or may not be a valid assumption. With some materials it may be the viscosity of the base asphalt, not the modified material, that correlates best with compactibility. In our example of the PG 46-34 modified to meet the PG 64-34, compaction temperatures typical of an AC-2.5 may be more applicable than temperatures for an AC-20. A straight-run PG 64 is normally an AC-20.

Obviously, for conventional materials, the compaction temperature for the AC 2.5 would be significantly lower than that for an AC-20. It is suggested that the purchaser follow the manufacturer's recommendations for mixing and compaction temperatures when using modified asphalts.

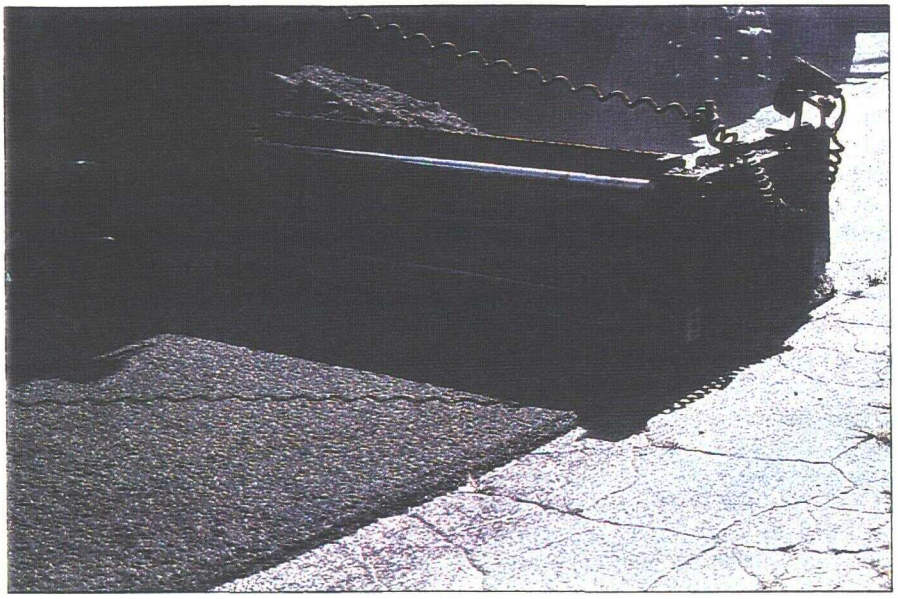
Fluids content

Some Indiana Superpave mixtures (a modified Superpave PG asphalt cement in a mixture designed using the Superpave Gyratory Compactor, SGC) have a 0.2% higher asphalt content than a conventional mixture (viscosity-graded asphalt in a Marshall design).

There are several reasons for the higher asphalt content. The rheology of the modified asphalt allows a thicker film of binder on the aggregate surface, therefore requiring more asphalt. The kneading action of the gyratory compactor also orients the aggregates within the specimen differently than the Marshall hammer. The improvements made by Superpave design methods should produce mixtures that are more



Most asphalt pavements have been constructed using a limited range of viscosity-graded asphalts.



Superpave has made many improvements to the durability of asphalt cement concrete pavements.

durable, but only if they are properly compacted on the pavement.

Total fluids is defined as moisture content plus total liquid binder minus the binder absorbed by the aggregate. The total fluids content is key to providing the lubrication necessary to achieve adequate field density.

Aggregates

The fluids content is further complicated with the presence of poor quality mineral fillers or plant returned fines (#200 and #325 sieve material) that may act as binder extenders. Superpave implementation is resulting in several unexpected consequences.

According to design criteria, Superpave mixtures can accommodate unwashed aggregates and mineral fillers, provided the Sand Equivalency, the Fine Aggregate Angularity and the Dust/Asphalt Ratios are within specified limits. Economic forces are driving an increased use of these less expensive material to fill the voids.

The result is a lower Voids in Mineral Aggregate (VMA) and ultimately a lower percent asphalt content at the 4% air voids required at N_{design}. Under the right conditions, poor quality mineral fillers or plant-returned fines filling the available VMA extend the binder, and therefore the apparent total fluids content.

Moisture

Obviously the moisture also is key in total fluids content. Inadequate drying of the aggregate through the hot-mix plant can cause a fluid imbalance that may aggravate the tenderness problem. Today's drum mix plants often have rated capacities of 400 tons per hour

and higher. Increasing production increases profitability. Unfortunately, heating wet stockpiled aggregates at high production rates can cause vapor pressure to rise inside the mixing drum. Until that free moisture is converted to steam and expelled through the exhaust stack, the aggregate materials will not heat above 212°F, the boiling point of water. The air intake of the burner and dwell times developed during high production periods are often insufficient to overcome the pressure and adequately dry the aggregates. Free moisture may still be present in the pores of the aggregate, while the aggregate surface is flash dried. The PG asphalt binder is then introduced onto a saturated surface dry aggregate particle, and the process of releasing the trapped moisture begins.

A small percentage of free moisture may enable the asphalt binder to more quickly coat the aggregates. However, it is generally accepted that moisture contents be no more than 0.5% by weight of mixture upon discharge. If too much moisture remains in the mixture after construction, the resulting pavement may be very susceptible to stripping or other forms of moisture damage.

Thicker binder films, while beneficial for mixture durability, can hinder the release of moisture trapped in the pores of the aggregate. In this scenario, the mixture may not exhibit the classic signs of excessive moisture, such as slumping or foaming in the haul trucks, or streaks in the mat directly behind the paver. The goal of producing any HMA mixture should be to remove as much moisture as possible while providing good asphalt binder coatings on the aggregate.

Conclusions

Using conventional guidelines for mix and compaction temperatures based upon laboratory viscosity measurements generally results in recommendations that are well above optimum temperatures for field construction when using elastomer-modified asphalt. Additionally, the active total fluids content of the mixture may be higher. Is the tenderness, then a surprise? What can be done to correct the problem?

The PG asphalt binder viscosity optimal for achieving compaction may be influenced more by the base asphalt than

Reducing or maintaining the pavement layer thickness used in the past could be contributing to some of the problems encountered during construction of Superpave mixtures.

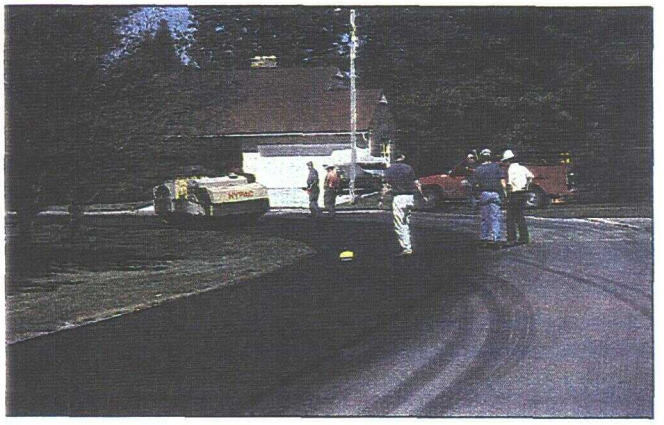
the increased stiffness provided by the modification. The rheology imparted by the type of modification is the key.

If it is suspected that the compaction temperatures are contributing to the tenderness, lower temperatures should be considered. The PG asphalt binder supplier should be able to help with recommendations for mixing and compacting for the specific material being used.

The total fluids content plays an important role on the compactibility of Superpave mixtures, based on possible increased binder contents and the higher acceptable levels of fines. Too much available lubrication can make the mix appear unstable. Additional drying time through the mixing drum or adjustments to the percentages of mineral filler or plant returned fines may be necessary.

It is especially important to recognize the possibility of increased entrapment of moisture when using aggregates that are highly water absorptive. The quality of the mineral filler itself, including baghouse fines, might also be a factor. Rigden voids or other measures of filler quality can frequently identify potential problems, particularly for SMAs or other high filler mixtures.

The lift thickness, in addition to the asphalt binder and aggregate material interaction, plays an equally important role in achieving adequate field density. While beyond the scope of this discussion, it is accepted that the thicker the lift, the easier it becomes to achieve pavement density in the field. It is the author's opinion that reducing or maintaining the pavement layer thickness used in the past could be contributing to some of the problems encountered during construction of Superpave mixtures. Consideration should be given to increasing layer thickness to overcome this problem.



If it is suspected that the compaction temperatures are contributing to the tenderness, lower temperatures should be considered.

Superpave has made many improvements to the durability of asphalt cement concrete pavements. As with any new system, however, allowances must be made for the unexpected changes. The tenderness problem discussed here is only an occasional occurrence, and the problem is not insurmountable, as demonstrated by the many tons of Superpave mixtures already successfully placed throughout North America.

To capture the value of the SUPerior PERforming Asphalt PAVEments, it is important to recognize the differences from the conventional methods, and adapt laboratory and field practices as necessary to take full advantage of the improvements. RB

The paving crew at work laying the thin-lift sand mix.

Thin-lift sand mix stretches maintenance dollars

Seeking a way to properly maintain its streets while conserving cash, a small Illinois town adds specially designed polymer-modified asphalt mix to its maintenance program

Roads are deteriorating throughout the U.S. at the same time cities, counties and states are having difficulty finding the funds to keep their roads in good condition. Inherent in this situation is the need for a cost-effective method of maintaining aging pavements.

The costs of traditional hot-mix asphalt (HMA) overlays sometimes can be prohibitive for small cities and towns. Thicker overlays also can cause problems with curb heights and drainage. While emulsion solutions, such as chip seals and slurry seals, are cost-effective for preventive maintenance, they are not designed for pavement with more serious distresses.

A study performed by Fehr-Graham & Associates, Freeport, Ill., concluded that a high-performance thin lift might be the answer to the city of Freeport's pavement maintenance dilemma.

Information for this article provided by Koch Materials Co., Wichita, Kan.

Innovative solution

Located in the northwestern region of the Land of Lincoln, the city of Freeport has a population of 26,000. A 1994 pavement management study completed by the city had touched on the possibility of a thin overlay. An analysis of eight-year-old pavement treatments showed little performance differences between thin and conventional thick overlays. As the pavement maintenance program was being developed for 1996, Craig LeBaron, the director of public works, favored the cost saving of thin lifts.

Fehr-Graham's Thomas Mathews proposed a polymer-modified binder coupled with a quality aggregate as a possible solution. Recent advances in modified asphalt, in aggregate quality standards, and in proof testing, have raised technology to a new level. This has resulted in the creation of alternatives for optimizing pavement designs and performance.

Mathews contacted Koch Materials Co., Wichita, Kan., who in conjunction with Chicago Testing Laboratory, Skokie, Ill., performed a mix design based on locally available aggregates and polymer-modified asphalt meeting Illinois SBS-10 specifications.

Continuing the feasibility study, Mathews contacted Bruce Helm of Civil Constructors Inc., Freeport, to determine the ability of local contractors to produce and lay the mix, and at what cost. The contractor said that problems had been experienced in the past with laying and rolling sand mixes. However, after further discussions that differentiated the high-performance mix

from previous mixes, Helm said he thought it was possible to produce and construct the proposed ¼-in. overlay.

Project specifications were finalized and the project was put out for bid. The contract included three maintenance operations: the polymer-modified sand mix thin overlay, a bituminous concrete surface course Class I mix with polymer-modified binder, and a seal coat using a high-float polymer-modified asphalt emulsion.

A breakdown roller in action on a residential street.

Because of the experimental nature of the high-performance sand mix, the city decided to use it on a variety of surface conditions ranging from minor cracking and segregation to heavy cracking, segregation and surface distortions.

Civil Constructors was low bidder for the project and performed the work in the summer of 1996. The city, which had feared the new materials would be more expensive, was pleased the winning bid was 5% below the original estimate. The polymer sand mix was 12% more expensive than the polymer bituminous concrete surface course, Class I mix, perhaps because of the unknowns of handling the experimental material. The cost of the sand mix is expected to decrease with experience.

The contractor decided to lay the conventional surface mix with polymer first, because he felt comfortable using the aggregate. A Cedarapids

Grayhound CR 451 asphalt paver placed the material. When the time came to lay the polymerized sand mix, the contractor faced resistance from its crew. Comments were made, such as, "This stuff won't work."

The contractor expected some balling up of the materials and rolling problems. Representatives from the polymer supplier and the engineering firm were present to observe and help with any problems. The problems did not materialize, and the material was easily laid. The biggest problem was keeping traffic off of the newly paved streets until they were completely rolled.

A thin-lift Troxler Nuclear Density test gauge was used to determine the density and the number of roller passes required. The mix was 88% compacted behind the screed, and required three roller passes to bring it to 92% to 96% compaction.

Vibratory rolling was not used for the thin-lift polymer sand mix, but an Ingersoll-Rand DD90 vibratory steel drum roller was used on the polymer surface course. A Case Corp. Model 252 finish roller was used, but not really needed because the three roller passes of the breakdown/intermediate roller had already accomplished the compaction. However, the finishing roller was helpful at smoothing out marks at drive approaches when it was run perpendicular to the road.

At temperatures greater than 300° F, the mat tended to stick to the roller, thus breakdown rolling was conducted at 270-275° F. It also was necessary to do any hand work before the temperature decreased. If the mix dropped below 190° F, the rollers were ineffective. If a ridge was left at this temperature, the roller could iron it out, but the ridge would spring back because of the elasticity of the polymer.

The sand mix was bid at $2.41/sq yd, compared to $3.28/sq yd for the ¼-in. conventional surface course mix with polymer, and $0.90 average chip seal costs. The cost of the sand mix is expected to drop slightly as it moves from experimental status to a standard mix.

Innovation

The inclusion of an elastomeric polymer offers several advantages. It is the polymer that reduces and slows cracking, allowing a thinner and therefore more cost-effective overlay. The polymer-modified binder is less susceptible to oxidative aging and premature brittleness. It accommodates thicker films on the aggregate

without danger of draindown.

The networked polymer is less temperature susceptible, resisting rutting at high temperatures and thermal cracking at low temperatures.

Koch tested the mix using a Hamburg wheel-tracking device. The test results confirmed that the proposed mix had the strength to resist rutting and stripping. The elastomeric binder also has greater durability in withstanding repeated loading in a flexible pavement. The mix was produced using a Barber Greene DM70 batch plant.

For the project, a chemically reacted styrene-butadiene block copolymer manufactured using Stylink technology and meeting Illinois' SBS-10 specifications was used. An elastomeric polymer, such as Stylink MAC-10, which meets elastic recovery and separation requirements gives the best results. The elastic recovery ensures the elasticity of the material. The homogeneity ensured by passing separation will prevent segregation of polymer and asphalt, and be easier to handle at the mix plant and in the field.

True to its name, the thin-lift mix is laid ¼-in. thick.

The aggregate is fine, and includes manufactured sands for strength. While this project used only crushed materials, subsequent testing has developed a mix using both crushed and natural sands. The crushed material gives skid resistance and the structural integrity to resist deformation. The natural sand increases the workability and decreases the cost. Windblown sands, baghouse fines, mineral fillers and dusty materials are to be avoided.

The mixture has relatively high binder content to enhance durability and interconnected voids to expel moisture and reduce the effects of hydroplaning and back spray. Skid numbers typically are in the low 60s if skid resistance materials are used, and the mix has AASHTO layer coefficients of approximately 0.40.

Use of a polymerized asphalt emulsion tack coat is strongly recommended on projects such as this to ensure bonding to the underlying surface.

Testing and photo documentation will continue on the sites in Freeport to track the long-term performance. To date, none of the sections show any significant signs of cracking. R_B

More information on products and/or services mentioned is available by circling the appropriate number on the reader service card found in this issue.

Polymer-modified asphalt
Koch Materials Co. — 927
Model CR-451 —
Grayhound asphalt paver —
Cedarapids — 915
Model DD90 vibratory steel drum compactor —
Ingersoll-Rand — 916
Model 252 compactor —
Case Corp. — 917

Conventional Concrete Overlay

Appendix A-2

Johns Manville International
Marrero, Louisiana

April 21, 1998
Job No. 6032-09

Prepared By:

ERM EnviroClean Southwest, LLC
3501 N. Causeway Blvd., Suite 200
Metairie, Louisiana 70002
(504) 831-6700

Standard concrete specifications and installation practices will be used in installation of the concrete overlay.

Concrete Overlay Containing Fibermesh

Appendix A-3

Johns Manville International
Marrero, Louisiana

April 21, 1998
Job No. 6032-09

Prepared By:

ERM EnviroClean Southwest, LLC
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a series of case studies detailing the wide ranging applications of Fibermesh® fibers

BUS MAINTENANCE CENTER

Large bus parking area.

Large Bus Maintenance Facility Designed For Hard Use Includes Fibermesh® Fibrous Concrete

New Orleans State-of-the-art Repair Center Goes all out for Concrete

Bus traffic can be tough on pavements. Particularly in a hot climate like New Orleans.

Constant bus movement–starting, stopping, turning and vehicles standing in blazing sunshine–it takes the lasting performance of concrete to withstand such day in day out pavement abuse. With fibrous concrete, there's no shoving, sinking-in or rutting of the pavement surface that could be the case with asphaltic pavement.

This new facility is used for the maintenance and repair of hundreds of city buses. It includes a 70,000 square foot garage with separate wash, lubrication and fueling facilities.

The planners of this demanding installation chose Fibermesh polypropylene fiber in addition to wire reinforcement to provide a belt and suspenders system of secondary reinforcement in all concrete. This includes all elevated slabs and paving where approximately 12,000 cubic yards of 4,000 psi concrete were placed.

Also going the fibrous concrete route is the 22,000 square foot administration building and large employee parking area.

Look at this proud achievement by the New Orleans Regional Transit Authority:

The 2-story administration building also has Fibermesh fibrous concrete.

Let's Take a Look Around...

Bus washing facility that contributes to the clean image of New Orleans bus service. Fibermesh polypropylene fiber increases concrete's resistance to early age plastic shrinkage cracking, thereby lowering its permeability. This added protection contributes to greater concrete performances in wet and dirty environments like this heavily used bus washing facility.

Large fibrous concrete employee parking area. The natural brightness of concrete pavement reduces nighttime illumination costs and contributes to a feeling of security and safety. The fibrous concrete, compared to asphaltic pavement, is unaffected by wide temperature fluctuations and drenching rains, providing protection against premature aging of the parking surface.

Some of the numerous bus maintenance bays. Here, the addition of Fibermesh fiber increased the concrete's resistance to impact and abrasion, valuable features in such demanding installations.

Another view of the two story administration building. Fibermesh fiber reinforcement was used here in the floor system to control plastic shrinkage cracking and add durability and impact resistance.

CREDITS:

Architect: Hewitt-Washington (Leonard Washington), 403 Baronne Street, New Orleans, LA 70113.

Engineer: Guillot-Vogt, 2720 Metairie Lawn Drive, Metairie, LA 70002..

Contractor: Woodrow Wilson Const., 2322 Tremont Drive, Baton Rouge, LA 70809.

Owner: Regional Transit Authority

Project: Regional Transit Authority East New Orleans Transit Facility

Ready Mix: Carlo Ditta, Inc., 1445 MacArthur Avenue, Harvey, LA 70058.

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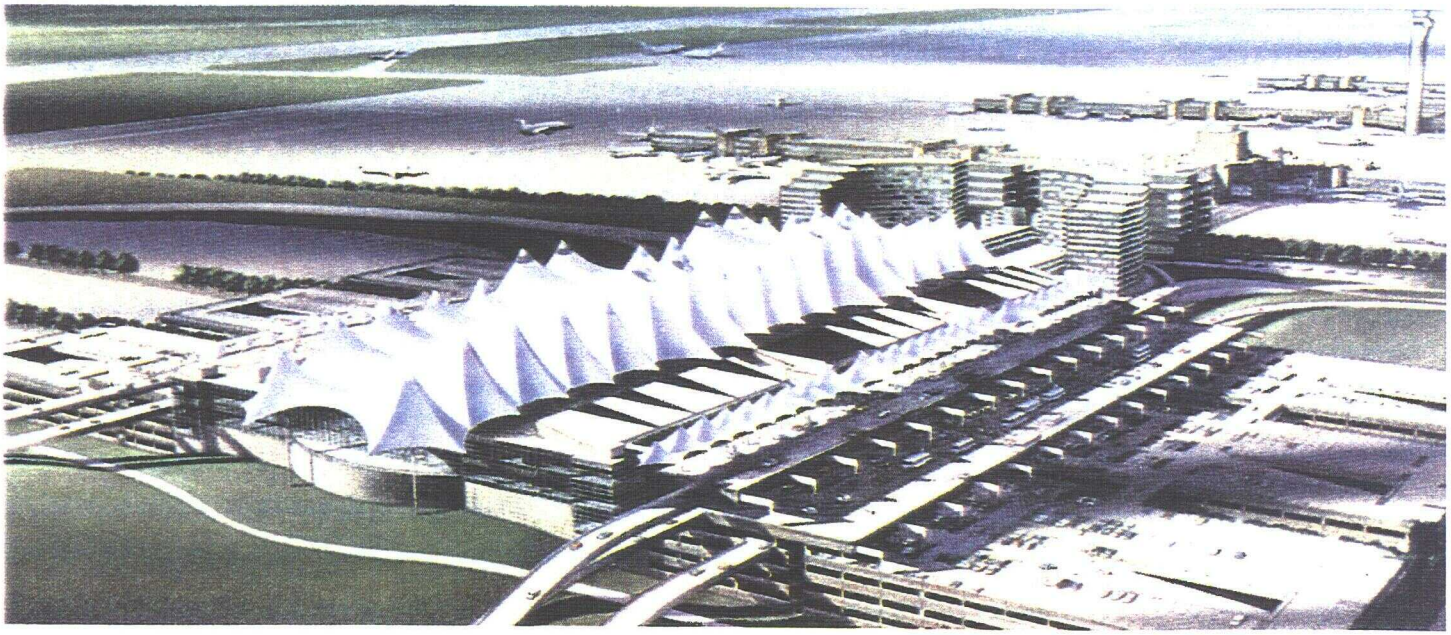
AIRPORT CONSTRUCTION



Artist's rendering of Denver International Airport. Illuminated from within, the translucent fabric presents a spectacular scene. Courtesy DIA.

Denver International Airport World's Third Largest Concrete Project

The Statistics of the New $3.2 billion Denver Airport (DIA) are staggering:

- It sprawls over 53 square miles (twice the size of Manhattan)
- It has designed capacity to handle 110 million passengers a year
- It has parking in six 4-story garages for 15,000 cars
- Its terminal undulating fabric roof has 120 foot high peaks (simulating snow capped Rockies)
- Its state-of-the-art runways are arranged pinwheel fashion
- Its silent automated guideway system speeds passengers
- **Altogether, over 4.8 million cubic yards of concrete were placed—making it the third largest concrete project in the world**

Fibermesh® Fibrous Concrete Specified for Numerous Areas in Immense Project

In planning the first major U.S. airport in two decades, Denver set its sights high.

This new facility leaps 20 years into the future with its high technology and construction concepts. Travelers approaching from the air and ground are immediately impressed by its undulating translucent fabric roof which complements the nearby scenic mountain peaks. This filters out ultraviolet light and saves on winter heating costs while flooding public areas with natural daylight.

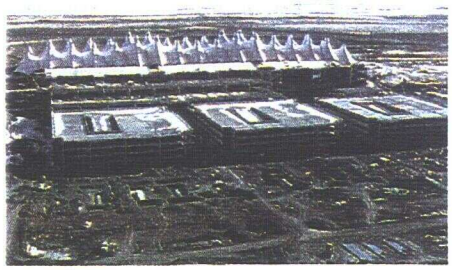
A Concrete Wonder

Concrete is the dominant construction material throughout the vast complex—runways, taxiways, plane parking aprons, parking garages, F.A.A. tower, terminal floor systems, underground transportation tunnel, airline maintenance facilities; you name it!

To meet the complex concrete demands of the project, the major concrete suppliers working with the airport's designers, tailor made the concrete mix for different applications. These included virtually every type of "high performance" component—silica fume, corrosion-inhibiting admixture products, high range water reducers, set controlling admixtures, Type A water reducers, class "F" fly ash, air entrainment and fibrillated polypropylene fibers.

Fibermesh MD fiber specified

The two major ready mix suppliers at D.I.A. were C&M Concrete Companies and Golden's Concrete Companies. In keeping with its policy of incorporating proved components in its high-performance concrete,



This construction view shows three concrete parking garages which are repeated on the other side of the main terminal. MD polypropylene fibrillated fiber supplied by Fibermesh Division was included in the concrete deck design.

Concourse B, at 3,199 feet, is the longest of the three concourse structures. It is designed for future installation of moving walkways. The 110,000 cubic yards of concrete has Fibermesh MD fiber reinforcement to reduce formation of plastic settlement and shrinkage cracking.

C & M Concrete Companies, a major concrete producer for the airport, utilized virgin polypropylene MD graded fiber manufactured by the Fibermesh Division of Synthetic Industries. C & M, in its computerized central mix concrete plant on the airport site, produced over 100,000 cubic yards of its exclusive Fiber Plus product. This was used in the parking garage structures, concourses A and B, the main terminal building, the terminal passenger bridge, the administrative office building and on several other contracts. Fibermesh polypropylene fibers substantially reduce the formation of plastic settlement and shrinkage cracks by increasing the tensile strain capacity of plastic concrete. The Fibermesh fibers provide multi-dimensional secondary reinforcement to the slab.

Fibermesh MD Fiber Exclusively Used.

Golden's Concrete Companies, utilizing an on-site concrete plant, provided several thousand cubic yards of concrete reinforced with Fibermesh MD, the only fiber specified for use at D.I.A.

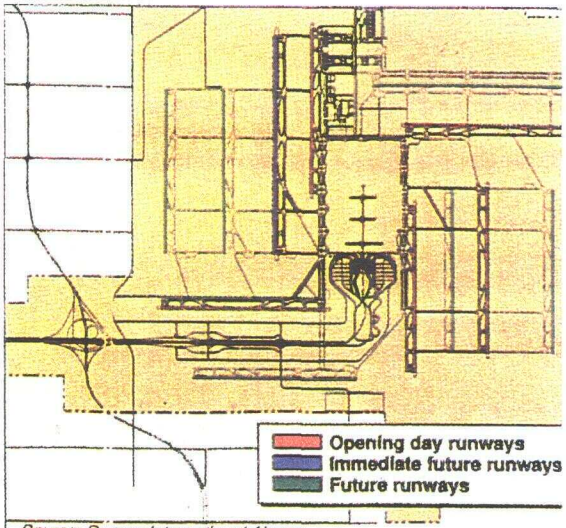
Included among its several major projects are the 11 story Administration Building which, in addition to personnel, houses the control center for the world's most advanced baggage handling system and the Air Cargo Complex with warehouse and office space for Federal Express, United Parcel Service and others.

Golden's also supplied Fibermesh fibrous concrete for concourse C and outlying structures, including several car rental agencies.

Fibermesh MD fibrillated fibers are engineered in multi-graded design configuration so they distribute more rapidly and uniformly throughout concrete's various mortar areas. The multiple fiber designs reinforce all the paste areas in the concrete mix for maximum density fiber performance and optimum post crack residual strength.

Called the crown jewel of 21st century aviation, Denver International Airport is poised for a dramatic role in the region's future growth. As an international marketplace, Denver is centered between Europe and the Pacific Rim. It is halfway between New York and California and halfway between Canada and Mexico. Its location indeed situates this great airport for great expectations.

Even the steel double deck passenger bridge connecting concourse A to terminal has fiber reinforcement in the concrete mix of the floor system.



Source: Denver International Airport

Pinwheel configuration of runways surrounds terminal and concourses. This four-quadrant design enables simultaneous use of three runways during Instrument Flight Rule conditions.

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AAA Auto Club Takes Fibrous Concrete Route In Whitetopping Award Winning Parking Area

Fibermesh® Fibrous Concrete Specified for Overlay and Building Floors

The AAA Hoosier Motor Club provides travel and insurance services to a wide range of members from its Lafayette, Indiana office. Parking for its constant stream of visitors and growing office staff was a problem. Its asphalt parking area was requiring excessive maintenance and repair. In the summer months, complaints of tracked in gummy asphalt were concerns.

When it was decided to modernize and enlarge its Lafayette facility, owner AAA Hoosier Motor Club, Indianapolis turned to Keystone Architecture, Inc., Lafayette for a modern design. This involved installation of a new concrete floor system for the two-story portion of the building at the rear and a new slab on grade at the front.

At the same time, it was agreed to go the concrete route and whitetop its ailing asphalt parking area. Working with the Indiana Fibermesh Manager, a fibrous concrete design was presented as the most effective and time saving method of reconstruction.

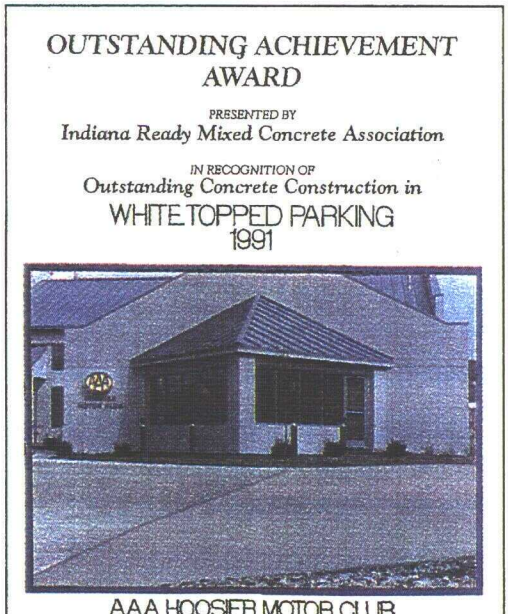
New Modern Look for Building and Parking Area

Final plans revealed an entirely new modern look to the building with a bright exterior appearance and colorful metal roof for accent interest. To insure a lasting, durable building floor system, Fibermesh fibrillated fiber reinforced concrete was supplied by the ready-mix producer, IMI, Lafayette.

As a key component in the whitetopping, the Fibermesh polypropylene fiber provides an internal support system to discourage the concrete's denser materials – cement and aggregates – from migrating downward, keeping all materials where they belong in the plastic concrete.

The entire old asphalt parking area received a 3½" whitetopping. This was easily accomplished with delivery of the fibrous concrete in IMI's front discharge mixers. The paving sequence was smartly planned leaving the

The renovated building and its bright concrete whitetopped parking area project a warmth and welcome to visitors.



AAA HOOSIER MOTOR CLUB

In recognition of "Outstanding Concrete Construction in Whitetopped Parking" the Indiana Ready Mixed Concrete Association presented this plaque to all involved.

center of three sections open until last. This way the mixers with extended chutes could conveniently place the concrete to either side from the center; which was then placed last (see photo).

Concrete More Durable and Light Reflective

The old asphalt parking area was transformed into an attractive new concrete surface. The concrete light reflectiveness contributes to better illumination of the parking area in evening hours and an enhanced sense of security to visitors.

Lafayette, Indiana is in a zone of severe weather conditions. There are many freeze-thaw cycles every winter. Fibermesh fibrous concrete is more durable and made to order for such environmental punishment.

With Fibermesh fiber reinforcement, the concrete gains a fibrillated toughness due to the uniform distribution of millions of polypropylene fibers throughout the concrete. This contributes to lower permeability because of the drastic reduction in plastic cracking. The benefit is obvious in freeze-thaw conditions; moisture and salt don't migrate into the concrete.

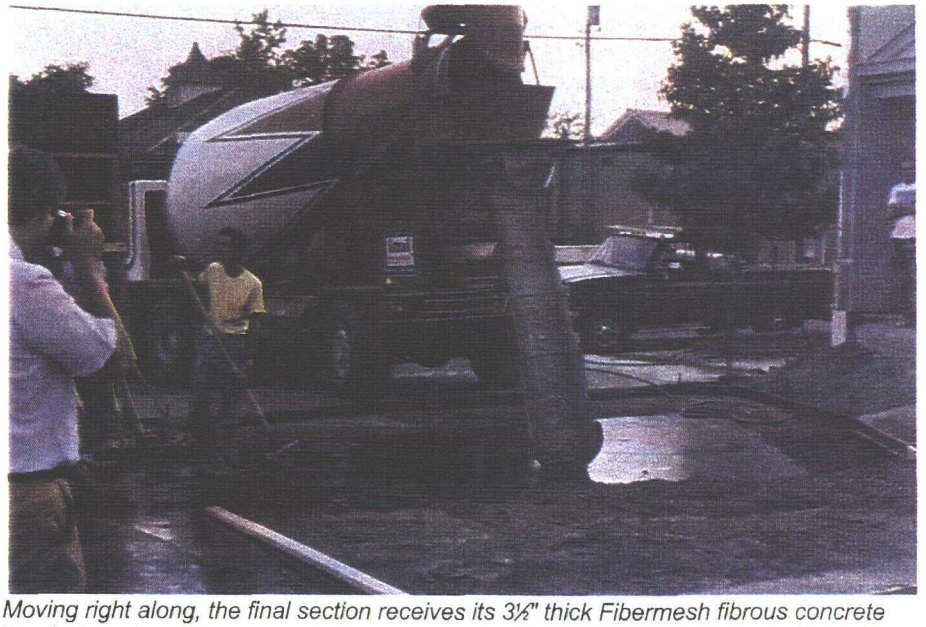
The Fibermesh fibers in the concrete also provide important post-crack residual strength in the hardened concrete.

By using Fibermesh fiber reinforcement as an alternate to wire mesh, time and money were saved. Also gone were potential rust stains due to steel corrosion. Fibermesh fiber is rust proof.

With several years of service now behind it, the Fibermesh fibrous concrete whitetopping at the AAA Hoosier Motor Club, Lafayette headquarters is smooth and crack free – unlike the bituminous pavement which was maintenance intensive.

CREDITS:
Architect/Engineer: Keystone Architecture, Inc., Lafayette, IN
Contractor: McCarthy Construction Co., Lafayette, IN
Concrete Supplier: IMI, Lafayette, IN
Owner: AAA Hoosier Motor Club, Indianapolis, IN

With one section of the parking area placed in background, the mixer located in the open center section was able to place concrete in the remaining areas.



Moving right along, the final section receives its 3½" thick Fibermesh fibrous concrete bonded overlay.

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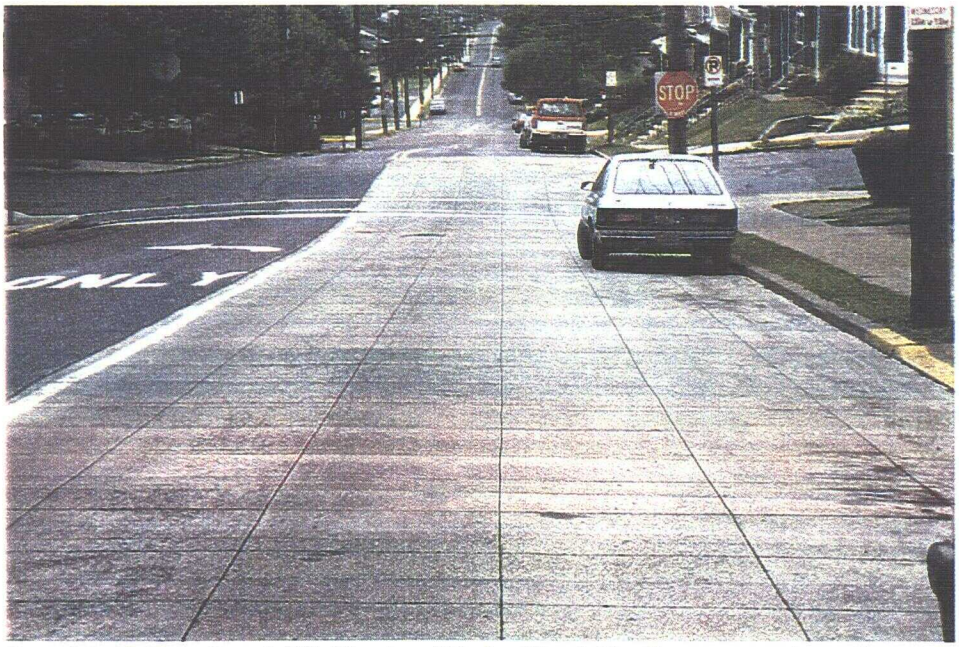
Ultra-Thin Whitetopping With Fibermesh® Fibrous Concrete Solves Troublesome Intersection Problems



Completed intersection at 18th Street and Linden Street. The fibrous concrete continues onto the cross street. On this downhill grade, the old asphalt suffered shoving and rutting. That's history now.


aci delaware valley chapter

american concrete institute

1995 GRAND PRIZE
CONCRETE RESTORATION & REHABILITATION

Presented to

FIBERMESH

For Excellence In Concrete Design
and Construction for

ULTRA-THIN CONCRETE WHITETOPPING
ALLENTOWN, PENNSYLVANIA

American Concrete Institute award by the Delaware Valley Chapter presented to Fibermesh for excellence in concrete design and construction for Allentown UTC whitetopping projects.

Award Winning Project Confirms Bright Future for Ultra Thin Whitetopping (UTW)

You know the problems with asphalt pavement at intersections. Repeated traffic braking particularly in hot weather causes rutting, shoving, raveling and general deterioration. It makes not only for poor rideability but also poses safety concerns, repeated maintenance and lane closures.

What Allentown, Pennsylvania offers as a solution to this problem promises reduced maintenance costs for them and for governmental agencies across the country.

The advancements of ultra-thin whitetopping have been rapid with developments in concrete mix designs and the advent of engineered synthetic fibers for secondary reinforcement.

In 1994, the Eastern Pennsylvania Concrete Promotion Association proposed that ultra-thin whitetopping be used for the reconstruction of two intersections in Allentown. A joint effort by several companies was organized.

Ultra-thin concrete whitetopping is a method of bonding high strength concrete to an existing asphalt base. The asphalt surface is milled and cleaned to remove all particles. The concrete is then placed, and finished. No bonding agents or cement slurries were required.

Placing/Finishing the Fibermesh Fibrous Concrete

The fibrous concrete was conventionally placed using a vibratory screed for consolidation. After profiling with a straightedge, the surface was tined or broom finished based on skid resistance requirements.

The surface was cured with an application of white pigmented curing compound. Control joints were cut to a depth of 3/4-inch. Joint spacing was 3-foot by 3-foot.

Fibermesh MD fibrillated polypropylene fiber was used exclusively for concrete reinforcement at the rate of 3 pounds per cubic yard. The polypropylene fiber reinforcement is an important part of the overlay because of the reduction of shrinkage cracking as well as contributing residual strength and impact resistance to the hardened concrete.

Fast Return to Service

The road was opened to service 24 hours after placement with a minimum compressive strength of 3,000 psi. After the first freeze-thaw season, the new ultra-thin whitetopped area has shown excellent durability.

Grand Prize Award Winner

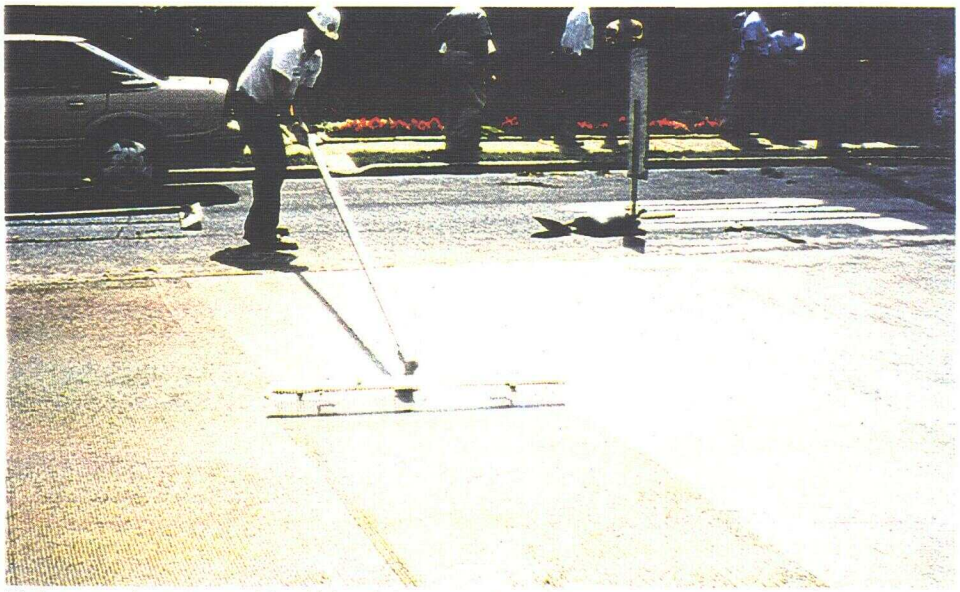
The Delaware Valley Chapter of the American Concrete Institute awarded the Eastern Pennsylvania Concrete Promotion Association the 1995 Grand Prize for Excellence in Concrete Design and Construction, Concrete Restoration and Rehabilitation Category.

The Fibermesh Division of Synthetic Industries also received a plaque acknowledging its contribution to this successful project.

CREDITS:

Organizer: Eastern Pennsylvania Concrete Promotion Association, Allentown, PA
Contractor: F.A. Rohrbach, Inc., Allentown, PA
Concrete Supplier: Frank Casilio & Sons, Inc., Bethlehem, PA

Startup of UTW placement, Ready Mix concrete is distributed on milled asphalt in front of the vibratory screed.



Tining was done to provide skid resistance on downhill area.

GENUINE FIBERMESH

MAKING GOOD CONCRETE BETTER®

SYNTHETIC INDUSTRIES

Fibermesh® Division

Fibermesh
4019 Industry Drive
Chattanooga, TN 37416 USA
Phone (423) 892-7243
Fax (423) 499-0753
E-Mail: fibermesh@aol.com
http://www.fibermesh.com

Fibermesh Europe Ltd.
Smeckley Wood Close,
Sheepbridge
Chesterfield S41 9PZ England
Phone (+44) 1246 453102
Fax (+44) 1246 455841

Printed in USA
FM-JR-139 5M 6/97

SPEC-DATA®

This Spec-Data sheet conforms to editorial style prescribed by The Construction Specifications Institute. The manufacturer is responsible for technical accuracy.

1. PRODUCT NAME

Collated, Fibrillated Polypropylene Fiber, FIBERMESH® and FIBERMESH® fibers with MICROBAN® "B"

2. MANUFACTURER

Fibermesh
a division of Synthetic Industries
4019 Industry Drive
Chattanooga, TN 37416
Phone: (423) 892-7243
FAX: (423) 499-0753

3. PRODUCT DESCRIPTION

FIBERMESH® fiber is specially engineered for concrete, manufactured in an ISO 9002 certified manufacturing facility to an optimum multi-design configuration from 100% virgin polypropylene which provides protection against non-structural cracks in concrete, increases abrasion resistance and impact resistance, and shatter resistance, while lowering the concrete's permeability, imparting toughness and residual strength to hardened concrete and is an alternate system to welded wire fabric when used for non-structural crack control of concrete. Fibermesh fibers with Microban® "B" actively fight microbial attack while providing secondary reinforcement in concrete.

FIBERMESH applications include, but are not limited to: slabs on grade, elevated slabs, precast concrete products, pavements, bridge decks, overlays, toppings, barrier walls, concrete tanks, pools, ditches, slope walls, stucco, shotcrete and gunite applications.

FIBERMESH fibers work without affecting the chemical hydration of the cement. Their action is purely mechanical and is compatible with all concrete designs and admixtures.

FIBERMESH fibers cannot rust or stain; they are non-corrosive and alkaliproof.

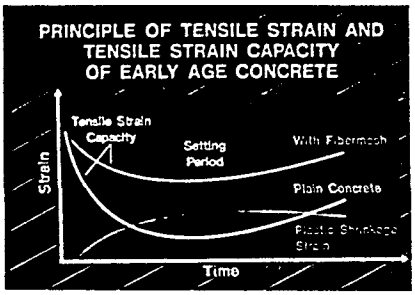
FIBERMESH fibers are easy to handle. The minimum application rate is 0.1% by volume, or 1.5 lb. per cubic yard (0.9 Kg/m³). Fibermesh fibers are packaged in pre-measured toss-in Fas-Pak® 2000 fiber bags.

4. TECHNICAL DATA

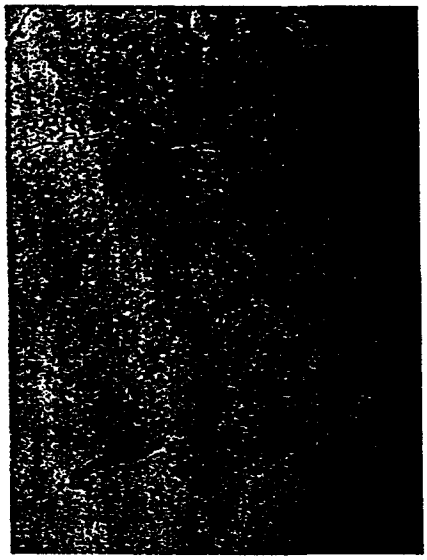
Extensive laboratory and field tests support the use of FIBERMESH fibers to inhibit the formation of concrete plastic shrinkage and settlement cracking and provide abrasion and impact resistance, provide shatter resistance while lowering permeability and imparting toughness and residual strength. The following reports represent the most comprehensive research conducted with FIBERMESH polypropylene fiber concrete.

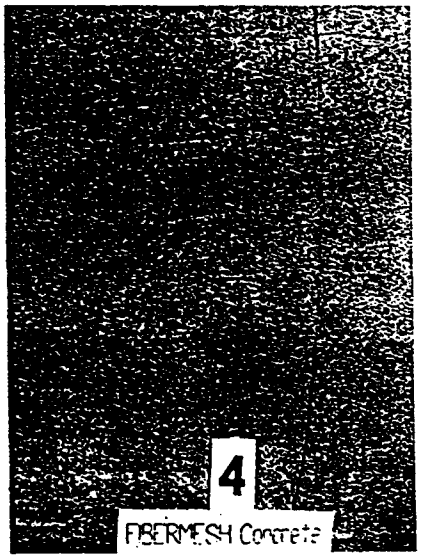
FIBERMESH Effect on Concrete Shrinkage Cracking: Tests run at San Jose State University and the University of California, Berkeley, confirm without exception that FIBERMESH fibrous concrete inhibits plastic cracking 90% to 100% compared to the non-fiber control specimen.

Relative Effect of FIBERMESH fibers on Early Age Plastic Shrinkage Cracking of Plastic Concrete: Tests by Webster Engineering and Associates, Inc. have shown that the addition of FIBERMESH fibers to plastic concrete substantially increases the resistance of the concrete to early age plastic shrinkage and settlement cracking.



Addition of 1.5 lb/cu. yd. (0.9 Kg/m³) of FIBERMESH polypropylene fibers increases the tensile strain capacity (ability to resist strain without developing visible cracking) of the immature concrete.

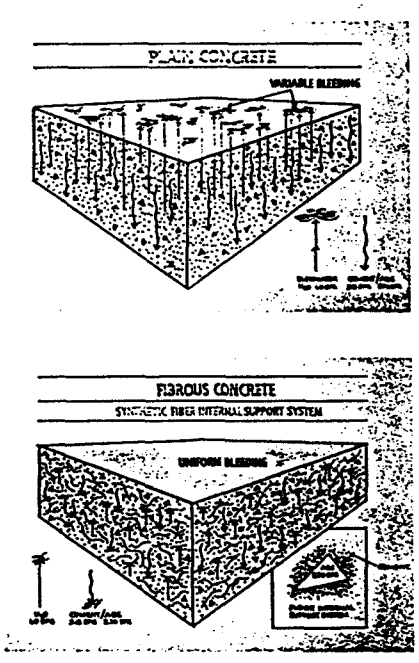




These accelerated test photos show a comparison between the two slabs at 24 hours. The cracking in the concrete slab without Fibermesh fibers started at 2.5 hours - most of the cracking patterns were developed at 4 hours. At 24 hours, and even after 28 days, the Fibermesh slab had virtually no cracking.

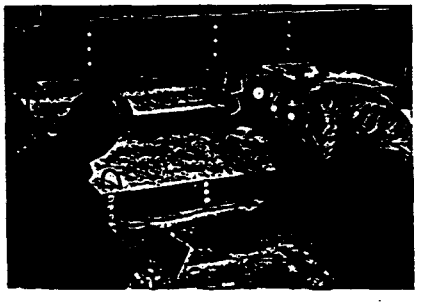
Polypropylene Fibers
(Supersedes August 1991)

Effect of FIBERMESH on Bleeding: The internal support system provided by FIBERMESH fibers results in more uniform bleeding because the water is not displaced and forced to the surface by the gravitational downward movement of the denser components. Uniform bleeding has the beneficial effect of limiting the formation and scope of bleed water capillaries.

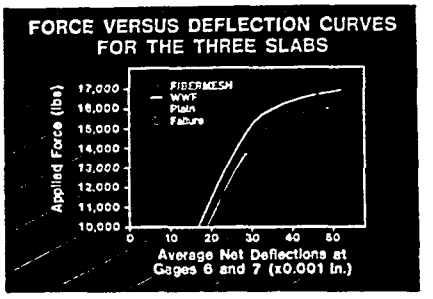


Fibermesh fibers provide internal support and uniform bleeding.

Static Load Test of FIBERMESH Fibers versus Welded Wire Fabric: The study was conducted in the laboratories of Wiss, Janney, Elstner & Associates, Inc., Consulting & Research Engineers by registered Professional Engineers. Results apply only to genuine FIBERMESH fibers. The results of the study confirm that substituting welded wire fabric with FIBERMESH fibers at a rate of 1.5 lb. per cubic yard (0.9 Kg/m³) of concrete yields: "Equivalent flexural strength capacity of the slab and equivalent load-deflection relationship."



Reading strain gauge on sample slab.



Engineers Conclusion: "The load-deflection data indicate that with respect to flexural response characteristics: FIBERMESH fibers can be used as a practical alternative to welded wire fabric, commonly used for shrinkage crack control purposes in essentially unreinforced concrete." Wiss, Janney, Elstner & Associates, Inc.

Relative Effect of FIBERMESH Fibers on Concrete Abrasion Resistance: A test program designed to evaluate relative abrasion resistance was developed to measure the effect of FIBERMESH fibers in concrete when exposed to excessive wear. The Army Corps of Engineers' "Method of Test for Resistance of Concrete or Mortar Surfaces to Abrasion" (Rotating Cutter Method CRD-C52-54) was used.

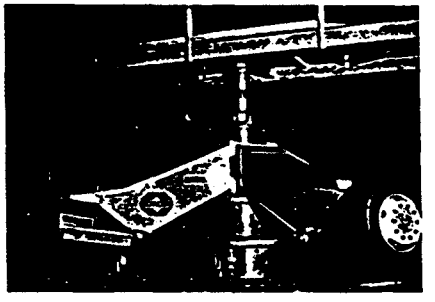


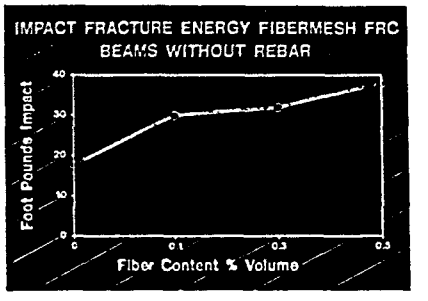
Photo courtesy of Norcem Cement A/S.

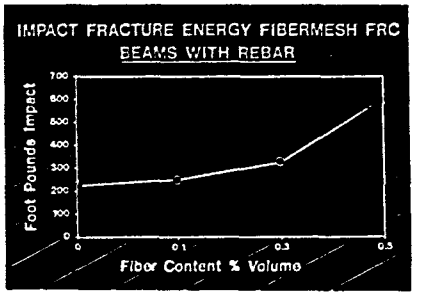
Test results indicate that the use of FIBERMESH fibers will increase the abrasion resistance by 105%, thereby doubling the serviceable surface life of concrete exposed to similar wear conditions.

Tests were also run in cooperation with the Norwegian Highways Laboratories on Norcem Cement's studded tire abrasion test machine. At 42 MPH (67 kmh), utilizing steel studded tires and 10 ton axle loads, the equipment accurately demonstrates the effects of 10 years of highway wear at the rate of 15,000 vehicles per day.

The FIBERMESH reinforced C-75 (75 MPa) specimen exhibited a 52% increase in abrasion resistance by sustaining 34.4% less material loss than the control specimen without fibers. Significantly, the C-50 (50 MPa) FIBERMESH reinforced specimen, containing less cement, exhibited a 20% increase in abrasion resistance over the C-75 control specimen by sustaining 17.2% less material loss. (The C-50 concrete has a base design strength of 7,252 psi while the C-75 concrete has a design strength equivalent to 10,878 psi.)

Relative Effect of FIBERMESH Fibers on Concrete Impact Resistance: Tests conducted at the University of British Columbia, utilizing an instrumented impact machine, indicate the foot pounds of energy to fracture beams with and without reinforcing bar as indicated in Tables 1 and 2.





The addition of FIBERMESH fibers inhibits crack growth by bridging the cracks that may develop. The addition also enhances the bond between the concrete and the reinforcing bars by inhibiting cracking of the concrete under bearing stresses in the vicinity of the bar deformations.

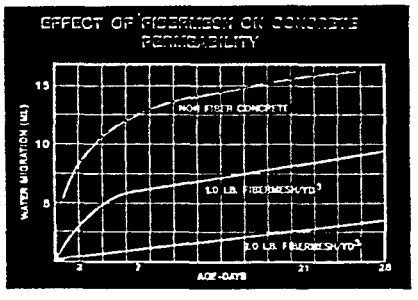
Shatter Resistance Under Compressive Loading of FIBERMESH Concrete versus Plain Concrete: This test program evaluated the shatter resistance of FIBERMESH concrete and plain concrete when exposed to crushing loads.

Research Engineer removes Fibermesh reinforced specimen after test. Column length was compressed 10% and still remained intact.

Results confirm that FIBERMESH reinforced concrete will sustain itself and not shatter even after 10% more compression than plain concrete which shattered completely shortly after first crack. This characteristic of FIBERMESH concrete is important to applications where there are impact or seismic concerns for safety to life and property, and relates directly to the added fibrillated toughness factor and residual strength of FIBERMESH reinforced concrete.

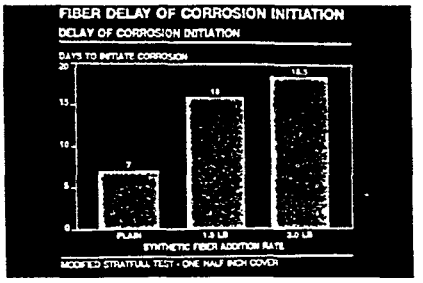
Water Migration/Permeability of FIBERMESH Concrete: The Von Test method was used to make this comparison at San Jose State University.

Migration of water rates indicated reduction in concrete permeability of 33-44% at 1 lb. of FIBERMESH fibers per cubic yard and as high as 79% at 2 lbs. per cubic yard.

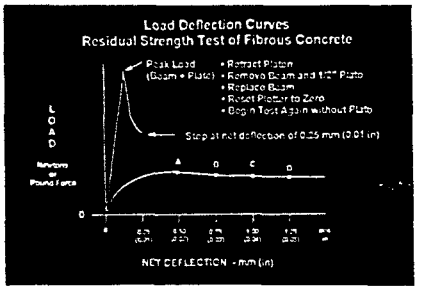


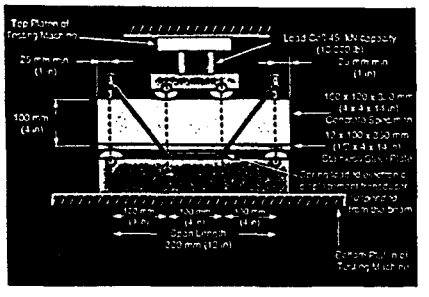
Effect of Fibermesh fibers on Concrete Permeability

Effects of FIBERMESH fibers in Reducing Corrosion of Rebar in Concrete. An extensive four year study conducted at Webster Engineering evaluated the long-term effects of FIBERMESH fibers in reducing corrosion of steel reinforcement. During the accelerated corrosion forcing phase of this study, results demonstrate the addition of FIBERMESH fibers delay the initiation and rate of corrosion of the steel reinforcement.



Residual Strength of Fibermesh Reinforced Concrete: Residual strength is a measurement of the reinforcing fibers' ability to hold cracked concrete together while sustaining a load measured at various net deflections. This test method demonstrates the performance level of the fibers in hardened concrete as a function of the type, physical configuration, and addition rate of fibers employed. Residual strength values are independent of the flexural strength of the tested concrete.



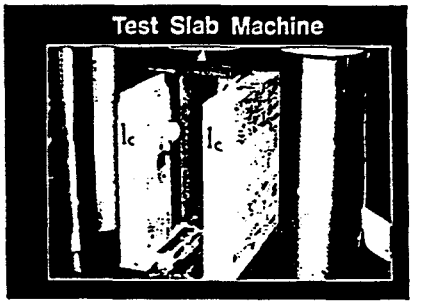


Residual Strength Test Apparatus

Fire Test of FIBERMESH Concrete Versus Welded Wired Fabric in Concrete: A series of fire tests were conducted by Underwriters Laboratories and Omega Point Laboratories using standard ASTM Test E 894, E 119 (UL 263) on various metal deck assemblies.

Underwriters Laboratories concludes that, based upon the full-scale fire test data developed with the use of FIBERMESH fibers in a protected concrete-steel form unit assembly, FIBERMESH fibers would be a suitable alternate to welded wire fabric in similar type constructions - D700 Series or D800 Series Designs. D900 Series tests result in a blanket recognition from Omega Point Laboratories for FIBERMESH fibers as a substitute for welded wire mesh in concrete walls, floor/ceiling and roof/ceiling assemblies.

Load Test of FIBERMESH fibers versus Welded Wire Fabric in Composite Deck Systems: Load tests which used the FIBERMESH fiber reinforced concrete were equal or better than the welded wire fabric reinforced concrete tests indicating an equivalency for structural performance in composite slabs as well as the diaphragm behavior. As a follow-up to the load tests, a test program was conducted on the strengths of headed stud shear connectors in concrete comparing the use of FIBERMESH micro-reinforcing system to the use of welded wire fabric.



Load Test of Fibermesh fibers versus Welded Wire Fabric in Composite Deck Systems.

The results of the Pushout Tests confirm that the strength and ductility of shear connectors in steel mesh and FIBERMESH fiber reinforced concrete are comparable. The use of FIBERMESH fibers also eliminates the construction problems experienced with welded wire fabric in metal decking and provides a consistent, easy and safe solution to the use and placement of secondary reinforcement.

Code Certification: FIBERMESH fibers comply with the BOCA Basic National Building Code and Supplements, the Standard Building Code, and the Uniform Building Code, as reported by the Council of American Building Officials, National Evaluation Service Committee - Report No. NES-284. FIBERMESH fibers are accepted by various State Departments of Transportation.

Projects Where Fibermesh Reinforced Concrete Has Been Specified:

Source: Ralph Robinson – Fibermesh Representative

Wal-Mart Stores Building Slab or Parking Lots – Acasanonala, Shreveport, LA

All Race Track Gas Station – in many States

Chevron Station – Beltway 8 @ Fallbrook (northwest)

Shoney's Parking Lot (1960 @ Willowbrook)

Sears Store Interior Slab 100,000 (Texas City Mall)

Texaco Station – Kirby @ Southwest Freeway

Chevron or Texaco – I-45 North @ Patton (Just north of N. Main)

Aspen Service Parking Lot – 26306 Aldine Westfield (behind Old Town Spring)

Flying J Truck Stop – Orange, Texas I-10 @ Bridge City Exit (15,000 cu. yds.) no steel

City of Houston Fire Stations- Greens Road @ Airport (8 yrs old and all newer fire stations)

Harris Co. Flood Control – Many channel linings around town I-45 @ Spring, another just north of Tomball, Texas

Newmark Homes – All their house slabs in the Greater Houston Area

Street Paving – Pasadena Highway 225 @ Shaver Street behind the *No Name* Barbecue (parallels Feeder Road)

Allegheny Center

December 1, 1993

Mr. George A. Henderson
Quality Systems, Inc.
President, Chief Executive Officer
501 Metroplex Drive
Suite 115
Nashville, Tennessee 37211

Dear George:

I'd like to express my appreciation for the superb 75,000 square foot PERMA CRETE installation which was recently completed by Quality Systems here at Allegheny Center Plaza.

This latest project is in addition to the PERMA CRETE surfaces installed by Quality Systems at Allegheny Center in 1990 as a test area to see how well PERMA CRETE would weather the Pittsburgh Winters.

As you originally promised to me before these projects began several years ago, PERMA CRETE has certainly withstood the harsh freeze-thaw and heavy snow conditions which are prevalent in Pittsburgh, Pennsylvania.

Because of our weather extremes and the heavy pedestrian traffic on the Plaza, as well as the continued delamination of the previous epoxy coating, we've had considerable expense each year for repairs and maintenance on this surface.

These annual expenditures have been necessary in order to maintain a stable, concrete surface of the Allegheny Center Plaza since it also provides the roof structure over three story, 3,000 car underground parking garage. However, our new PERMA CRETE surface will drastically cut these expenses!

PERMA CRETE is easy to clean and maintain; retains its attractive appearance and durability despite winter temperatures and summer heat; and, best of all, it's saving us thousands of dollars in continued repair and maintenance costs!

We look forward to future PERMA CRETE projects in other areas here at Allegheny Center Plaza in the years to come. Keep up the good work!

Regards,

ALLEGHENY CENTER ASSOCIATES

David M. Knight
President

DMK/ll12-1-5

CHEMPROOF POLYMERS®
INCORPORATED

2750 W. Charles Page Boulevard
Tulsa, Oklahoma 74127
918/584-0364, Fax 918/584-0366

January 27, 1998

Ms. Robin Mann
ERM-Southwest, Inc.
16300 Katy Freeway, #300
Houston, TX 77094-1611

Re: Asbestos Driveway Encapsulation

Dear Ms. Mann:

This letter is to follow up on your conversations with Gene Schisel of ICS Inc. regarding the above referenced encapsulation.

For asbestos encapsulation we recommend applying 1/8 inch PermaTec 3000 industrial floor coating directly over the asbestos concrete. The PermaTec 3000 system is an epoxy based systems with a silica filler providing a non slip surface.

The PermaTec 3000 system is totally non porous, stronger than concrete, and will adhere tenaciously to the concrete, i.e. the concrete will fail before the bond to the surface fails.

The PermaTec 3000 system is the same type system that has been used successfully for several PCB encapsulations across the country.

The price for the PermaTec 3000 product at 1/8 inch is $1.71 per square foot based upon the quantities expected for this project, fob Tulsa, OK.

This price does not include the labor cost which we can provide to you as needed.

I am faxing a technical data sheet for the PermaTec 3000 for your review.

Please call me with any questions.

Very Truly,

Marty Testa

Marty D. Testa
ChemProof Polymers, Inc.

CC: Gene Schisel, CCI, Inc.
MDT/bg

Allegheny
Center

December 1, 1993

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Quality Systems, Inc.
President, Chief Executive Officer
501 Metroplex Drive
Suite 115
Nashville, Tennessee 37211

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Regards,

ALLEGHENY CENTER ASSOCIATES

David M. Knight
President

DMK/ll12-1-S

Acrylic Polymer Modified Concrete Overlay

Appendix A-4

Johns Manville International
Marrero, Louisiana

April 21, 1998
Job No. 6032-09

Prepared By:

ERM EnviroClean Southwest, LLC
3501 N. Causeway Blvd., Suite 200
Metairie, Louisiana 70002
(504) 831-6700

PERMA • CRETE®

Resurfacing Products

World Wide

Detailed Installation Procedures & Material Safety Data Sheets Available From Manufacturer

FEATURES

A PERMA• CRETE® surface is a three-part, acrylic polymer cementatious resurfacing system of over 6000 PSI compressive strength that provides an architectural, load-bearing surface. It's sealed and non-porous, resists chemicals and withstands freeze-thaw cycles as well as intense heat and ultraviolet sun rays. It can easily be applied over such existing surfaces as concrete, aggregate, masonry, steel, asphalt, foam or wood.

PRODUCT

The three parts of a PERMA• CRETE® system are: (1) A Matrix Mix of high early-strength concrete compounds and specially blended additives which are mixed with one of twenty (20) standard, or other custom, water-base pigment dispersion Colorants. (2) A chemical Bonding Additive which is a high solids, water soluble acrylic polymer resin that is mixed with the Matrix Mix and especially designed to provide enormous surface strength and lasting adherence to the surface. (3) Two applications of an acrylic resin Stain Sealer (available in solvent or water base) formulated with special acrylic polymers, chlorinated rubber, epoxy resin and quick evaporating solvents in the same color as the Matrix Mix in one of twenty (20) standard, or other custom, colors to provide additional strength and continued protection for the Matrix Mix application.

USAGE

Resurfacing with PERMA• CRETE® renews instead of removes; enhances property values; and is a cost effective way of addressing the continual problem of existing surface deterioration and ongoing surface maintenance which is so prevalent in high traffic and commercial surface areas. New surface projects are equally benefited by the strong, durable and attractive finish with lasting protection which is assured from PERMA• CRETE®. Even underwater surfaces provide superb applications!

ARCHITECTURAL SPECIFICATIONS

Test	Method	Results
Compressive Strength	ASTM C-109	5690 PSI*
Flexural Strength	ASTM C-348	1835 PSI
Tensile Strength	ASTM C-190	855 PSI
Shear Bond Adhesion	ASTM C-882	>650 PSI
Impact Strength	LAB METHOD	22 in./lb.
Abrasion Resistance	ASTM C-944	1.57 % Wt. Loss
Slip Resistance	ASTM D-2047	0.78 Dry
Slip Resistance	ASTM D-2047	0.74 Wet
Water Absorption	ASTM C-642	6.5% (72 Hrs.)
Weight (Cured)	1/8" Typical Thickness	1.12 lbs./ft.
Freeze-Thaw	ASTM C-666	<0.5% Wt. Loss
Accelerated Weathering	ASTM G-23	Unaffected (4000 Hrs.)
Chemical Resistance	ASTM D-2299	Unaffected
Fire Resistance	ASTM E-108	Class A
Fire Resistance	UBC 32-7	Class A
Flame Spread	ASTM E-84	Exceeds Std.
Fire Resistance	ASTM E-119	Passed @ 1 Hour
Wind Uplift	FM I-52	Exceeds Std.
Moisture Resistance	ASTM D2247	Unaffected @ 6 wks.
Mildew Resistance	ASTM G-21	Class A
Mildew Resistance	MIL 810-B	No Growth @ 8 wks.
Wind Driven Rain	TTC-5556	No Penetration
Shrinkage	ASTM C-596	Exceeds Std.

* 6000+ PSI compressive strength is achieved after final applications of PERMA• CRETE® acrylic Sealers.

CHEMICAL RESISTANCE PROPERTIES

COMMERCIAL DESCRIPTION	CONCENTRATED REAGENT	PERMA• CRETE® Acrylic Sealers		PERMA• CRETE® Epoxy Sealers	
Acids					
Acetic	CH_3COOH	8	3	10	6
Hydrochloric	HCl	9	6	10	8
Nitric	HNO_3	7	2	10	4
Sulfuric	H_2SO_4	10	8	10	8
Alkali					
Potassium Hydroxide	KOH	10	10	10	9
Sodium Hydroxide	NaOH	10	10	10	9
Solvents					
Diesel Fuel	Hydrocarbons	10	9	10	10
Gasoline	Hydrocarbons	10	4	10	8
Mek	$CH_3CH_2COCH_3$	6	2	10	4
Oils	Hydrocarbons	10	10	10	10
Toluene	$C_6H_5CH_3$	8	2	10	5
Xylene	$C_6H_4(CH_3)_2$	8	2	10	6
Stains					
Coffee	Mixture	10	10	10	10
Cola	Mixture	10	10	10	10
Grape Juice	Mixture	10	10	10	10
Mustard	Mixture	10	10	10	10
Red Ink	Mixture	10	10	10	10

SEALER SCALE: 1 = Severe ... 10 = Unaffected

PREPARATION

If previous coatings of paint, glue or varnish are present, they're removed with Perma• Strip. Then the PERMA• CRETE® surface application begins with a thorough cleaning of the surface area using Blue Nitro or Orange Power high concentrate, liquid cleaning compounds applied as necessary for the exact condition of each surface. Cracks are then repaired by sawing out each crack slightly deeper than its existing depth. This ensures good bonding for repair with Perma• Bond methacrylate or Perma• Gel epoxy. If severe spalling, surface deterioration or low areas exist, these are leveled as needed with a non-colored skim coat of the Matrix Mix and usually applied by using squeegees or a spray rig and hopper gun assembly.

APPLICATION

The colored texture coat of Matrix Mix is then applied with the spray hopper and hand troweled to achieve the desired finish. After all expansion joints have been caulked with Perma• Caulk, two coats of Stain Sealer are then applied to the textured finish which completely seals the surface and enhances the Matrix Mix Colorant. Tile and brick patterns or other designs can be achieved by taping the pattern design after a skim coat and then applying a texture coat. Stain Sealer is applied during each separate application of a two-color Matrix design system.

MAINTENANCE

The result is an outstanding, durable and attractive surface which is amazingly easy to maintain with normal household detergents. Safety considerations are enhanced by the increased slip resistance of PERMA• CRETE® surfaces. Independent testing has determined that PERMA• CRETE® surfaces are over 50% more slip resistant than the minimum Federal Trade Commission (FTC) requirement for an FTC designation as a slip resistant surface!

WARRANTY

Manufacturer's 10 Year Warranty issued upon installation to suitable surface in accordance with specific installation procedures provided by PERMA• CRETE®.

Authorized Dealer:

Note: Authorized Dealerships are independently owned and operated.

A Division of Quality Systems, Inc.

Manufactured by a Division of Quality Systems, Inc.

PERMA•CRETE®
501 Metroplex Drive • Suite 115
Nashville, Tennessee 37211 • USA
(615) 331-9200 • FAX (615) 834-1335

Tech Cote Coating

Appendix A-5

Johns Manville International
Marrero, Louisiana

April 21, 1998
Job No. 6032-09

Prepared By:

ERM EnviroClean Southwest, LLC
3501 N. Causeway Blvd., Suite 200
Metairie, Louisiana 70002
(504) 831-6700

TECH-COTE™ POLYMER SYSTEMS INC.

13644 N 19th Ave. Phoenix Arizona, 85029 • (602) 942-1775 • (800) 494-1775 • Fax: (602) 942-2828

PRODUCT DESCRIPTION

Tech-Cote TCPR is a specially formulated blend of acrylic polymers used to enhance the performance of Portland cement compounds. TCPR offers an emulsion of the best polymers in order to achieve four critical goals: UV resistance, adhesion, texture and flexibility. Until now, single components were used with the only goal being adhesion. In order to achieve adhesion over time, Flexural and UV resistance are critical. TCPR modified cements shows dramatic improvement in these areas. Major limitations of conventional cement are overcome when modified with TCPR and mixed with the associated engineered aggregate. With it's superior adhesion and flexural strength, overlays of a 1/16 inch are common and can be featheredged to zero without loss of integrity. TCPR concrete is equally suitable for interior or exterior use and has proven durability when exposed to repeated thermal cycling and freeze-thaw conditions. It cures rapidly yet allows plenty of time for application. It can be coated with waterlaced sealers just hours after initial application. TCPR is environmentally safe, non-toxic and cleans up with water.

Product Uses

TCPR cement is ideally suited for the repair and resurfacing of damaged or unattractive concrete. It is commonly used as an overlay material on driveways, sidewalks, parking decks and industrial floors. Leveling, patching and spall repair are done easily and economically. TCPR cement may be used to smooth heavily shotblasted floors prior to coating. Unsafe, smooth troweled concrete can be overlaid to produce a textured, slip-resistant surface.

TCPR cement can be installed to produce a variety of aesthetically pleasing decorative effects. These systems can be integrally colored or stained after the installation to convincingly simulate brick, tile or material stone. They are typically sealed with clear acrylic or urethane to provide a stain-resistant and easily cleaned surface. The customer may choose a high-gloss or satin finish. These decorative overlays are an excellent choice for commercial applications such as automobile showrooms, retail stores, lobbies and hotel entryways. TCPR cement is preferred as a pool deck resurfacing material because of its slip-resistant texture and cool walking surface.

TCPR cement may also be used as an underlayment for tile and other types of flooring, tennis court resurfacing and as texturing on drywall. TCPR liquid can also be used as a general admixture to improve the performance of plaster, stucco and other cementious materials.

Chemical Composition

A proprietary acrylic co-polymer emulsion.

Colors

Natural white concrete color may be modified to suit any decor

Limitations

- Surface must be structurally sound and properly prepared.
- Application temperature must be at least 45 degrees and rising.

TECHNICAL DATA

Physical Properties

Appearance.....milky white or pastel liquid
Solids Content, by weight.....48-50%
Viscosity, cps.....1500
Pounds per gallon.....8.8-9.0

Performance Properties

TCPR modified cement (polymer solids/ratio of .2 by weight) was compared to conventional concrete (water/cement ratio .5 by weight). The following improvements were noted in the TCPR Concrete.

Compressive Strength.....increase of 200%
Tensile Strength.....increase of 300%
Flexural.....increase of 300%
Impact Resistance.....increase of 400%
Water Resistance.....increase of 400%
Shear Bond Adhesion.....increase of 1000%
Abrasion Resistance.....increase of 1300%

New concrete should be cured a minimum of 14 days. Surface must be clean, structurally sound and free of grease, oil or unsound coatings. Surface may be prepared by machine scrubbing with a detergent, high pressure water blasting, or acid etching combined with a non sudsing detergent wash. Acid etching is done not so much to profile the concrete, but to remove any laitance, unsound concrete or mildew. The etching solution should be 4 parts water to 1 part muriatic acid. Spread the solution with a sprinkling can and scrub vigorously with a stiff-brushed broom. Do not allow the etching solution to dry on the concrete during the process. after etching, rinse well. Neutralize with 1 pint of household ammonia to 4 gallons of water. Scrub the surface again and rinse well.

Mixing Instructions

TCPR cement is a mixture of TCPR liquid polymer, water and the Tech-Cote dry mix. The dry mix (50 pound bags) contains cement and engineered aggregates which minimize or eliminate shrinkage. The TCPR should be reduced with 2 parts water before blending with the dry mix (5 gallons of polymer plus 10 gallons of water = 15 total gallons). Mix until thoroughly homogenized. This 2 - 1 mixture will be referred to as the diluted mix. Most TCPR cement applications consist of 2 coats: the squeegee/bond coat and the texture/finish coat. Mixing and coverage rates are as follows:

1) Squeegee/bond coat - Mix 2 -2.5 gallons of diluted TCPR with 1 bag of the dry mix. This conveniently fits into a 5 gallon bucket. Pour mix until homogenized and avoid pumping the mix full of air by keeping your bit submerged. This mix will cover 250 to 350 sq. ft. depending on substrate and applicator.

2) Texture/finish coat - Mix 1.5 to 2 gallons of liquid with 1 bag dry mix. Power mix as described above. One bag of dry mix plus diluted TCPR will cover 90-130 sq. ft. depending on texture and application method.

Application recommendations

There are many types of application techniques, mix designs, pigmenting and seal coat options for TCPR cements. For details please see the application guide or inquire about training.

Polibrid 705 Coating

Appendix A-6

Johns Manville International
Marrero, Louisiana

April 21, 1998
Job No. 6032-09

Prepared By:

ERM EnviroClean Southwest, LLC
3501 N. Causeway Blvd., Suite 200
Metairie, Louisiana 70002
(504) 831-6700

POLIBRID® 705

TECHNICAL DATA

SOLVENTLESS ELASTOMERIC POLYURETHANE PROTECTIVE COATINGS AND LININGS

GENERAL PROPERTIES

POLIBRID 705 is a tough, flexible and resilient elastomer used as a protective coating or lining for concrete, steel and other surfaces. It is airless-spray applied at ambient temperatures at virtually any film thickness in one application, even on vertical or inverted surfaces.

POLIBRID 705's solventless formulation and unlimited film build capabilities permits application of different film thicknesses within the same application; from 20 to 250 mils, or higher, as required by differing service demands or surface conditions. The degree of protection is no longer limited to the maximum build of multiple coats of solvent based coatings. Encapsulates rivets, bolts, edges, rough welds in one coat and produces the high film thickness needed to provide monolithic protection over naturally rough concrete.

POLIBRID 705 is a premium-quality, thermosetting elastomer that meets all known VOC regulations and is virtually odorless during and after application. It eliminates creation of pinholes due to solvent evaporation, producing a dense monolithic membrane. It is sufficiently elastic to withstand normal shrinkage cracks in concrete without breaking. An ideal immersion lining, it is abrasion-resistant, chemical resistant, highly impermeable and can be placed in service within moments after application. Easy to repair if needed.

RECOMMENDED USES

POLIBRID 705 provides the ultimate in corrosion protection for concrete or steel in potable water service. Protects against microbiologically induced corrosion (MIC), making it ideal for municipal wastewater applications. Geotextile fabrics may be embedded within the coating to produce reinforced, bonded geomembrane linings. Suitable for a wide range of industrial applications, including:

- **Potable Water Treatment & Storage Tanks**
- **Wastewater Collection & Treatment Structures**
- **Secondary Containment Installations**
- **Hydroelectric Penstocks & Dam Gates**
- **Tank Linings & Bottoms**
- **Pipeline Coatings & Linings**
- **Marine Vessels & Offshore Structures**

DRINKING WATER COMPONENTS CLASSIFIED BY UNDERWRITERS LABORATORIES INC.® IN ACCORDANCE WITH STANDARD ANSI/NSF 61-1996 — 7P59

Meets ANSI / AWWA C210-92 Pipe Inside / Outside

LIMITATIONS

Not recommended for exposure to concentrated acids, aromatic hydrocarbons, ketones or chlorinated solvents.

GENERIC TYPE	Solventless, Elastomeric Polyurethane Aromatic, Chemical Cure (ASTM D16 Type V)
COLOR *	Tan
SOLIDS CONTENT	100%
VOC CONTENT	0.0 lbs/gal (0.0 g/l)
MAXIMUM BUILD	Unlimited
FILM SHRINKAGE	Zero (Wet to Dry)
TENSILE STRENGTH	2,878 psi (ASTM D412)
ELONGATION	52% (ASTM D412)
HARDNESS	Shore "D" 61-65 @ 77°F (25°C) (ASTM D2240)
FLEXIBILITY	Passes multiple bends on 1/8" diameter mandrel @ 30 mils (ASTM D1737)
ABRASION RESISTANCE	36.7 mg weight loss Taber Abraser w/ CS-17 wheels; 1,000 cycles; 1 kg load (ASTM D4060)
TEAR RESISTANCE	352 lbf/in (ASTM D624)
COMPRESSIVE STRENGTH	> 4,500 psi (ASTM D695) Full recovery when load is removed.
IMPACT RESISTANCE	> 160 in-lbs / Direct and Reverse (ASTM D2794)
WATER VAPOR TRANSMISSION RATES (WVTR)	40-45 mils - 0.080 gm/100 in² / 24 hr 75-80 mils - 0.016 gm/100 in² / 24 hr at 100% RH and 73°F (23°C) (ASTM F-1249-90) WVTR too low for measurement per ASTM E-96 Methods "A" & "BW"
CATHODIC DISBONDING	Passes ASTM G8 Passes DIN 30671
FRICTION COEFFICIENT vs. ICE	0.14 / Breakaway 0.06 / Static 0.06 / Kinetic
SERVICE TEMPERATURE RESISTANCE **	Dry: -20°F to 180°F (-29°C to 82°C) Immersion: Maximum 120°F (49°C) (Ambient for Non-Insulated Tanks)

* Due to its aromatic composition, Polibrid 705 will tend to yellow or darken in color after exposure to UV light. For a color-fast, glossy finish, topcoat with an aliphatic polyurethane in a color of your choice.

** Raw water in carbon steel vessels. Temperature resistance of the lining may be substantially affected by chemical composition of the immersion solution.

Manufactured By :
POLIBRID COATINGS, INC.
6700 F.M. 802, Brownsville, TX 78521
Tel. (210) 831-7818 / Fax (210) 831-7810

Distributed By:
CARBOLINE COMPANY
350 Hanley Industrial Ct., St. Louis, MO. 63144-1599
Tel. (314) 644-1000 / Fax (314) 644-4617

Permatec 3000 Coating

Appendix A-7

Johns Manville International
Marrero, Louisiana

April 21, 1998
Job No. 6032-09

Prepared By:

ERM EnviroClean Southwest, LLC
3501 N. Causeway Blvd., Suite 200
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PermaTec 3000

For Protection Against Industrial Chemicals

DESCRIPTION

PERMATEC 3000 is a 100% solids epoxy floor topping. The PERMATEC 3000 system consists of a two component resin binder and graded aggregate. It is applied with a trowel or screed rake at 1/8 - 1/4 inches (125-250 mils) in a one coat application including a silica broadcast. There is no need for a primer or sealer coat. An optional glaze coat may be used to improve the appearance and cleanability.

The vertical formulation of PERMATEC 3000 is trowel applied at 1/8 inches (125 mils).

FUNCTION

The primary use of PERMATEC 3000 is as a high strength floor topping for industrial service where severe mechanical abuse and/or chemical exposure is anticipated.

TYPICAL APPLICATIONS

- Process floors
- Containment basins
- Trenches
- Sumps
- Tank bases
- Any area in general where harsh chemicals are used

FEATURES

PERMATEC 3000 is a 100% solids system and allows for a fast application where good chemical and wear resistance are required. PERMATEC 3000 can be installed over most sound floors including old or new concrete and most types of repair mortars. At varying thicknesses up to 1/4 inches, the PERMATEC 3000 system provides long term chemical resistance for splash and spill, or immersion service in many chemicals. (For specific recommendations refer to the "Chemical Resistance Guide" and your local distributor.)

As with all PERMATEC systems, PERMATEC 3000 provides excellent physical protection even in the harshest industrial settings. The physical properties of PERMATEC 3000 are many times those of standard concrete.

OTHER FEATURES INCLUDE:

- Rapid cure resulting in minimal downtime
- 100% nonporous
- Can be applied over damp concrete
- Odor-free
- Nonskid safety finish

TYPICAL PROPERTIES

Solids, by Volume	100%
Compressive Strength ASTM C579	11,400 psi
Flexural Strength ASTM D790	4,000 psi
Tensile Strength ASTM D307	2,100 psi
Bond Strength to Concrete ASTM D4541	Exceeds tensile strength of concrete. Failure in concrete
Taber Abrasion ASTM D4060 CS 17 Wheels	Loss/1000 cycles=25mg
Water Absorbtion ASTM D413	0.10% Maximum
Shore D ASTM D2240	85

CHEMPROOF POLYMERS INCORPORATED

2750 W. Charles Page Blvd. • Tulsa, OK 74127 • 918/584-0364 • Fax 918/584-0366

CHEMPROOF POLYMERS ®
INCORPORATED

2750 W. Charles Page Boulevard
Tulsa, Oklahoma 74127
918/584-0364, Fax 918/584-0366

January 27, 1998

Ms. Robin Mann
ERM-Southwest, Inc.
16300 Katy Freeway, #300
Houston, TX 77094-1611

Re: Asbestos Driveway Encapsulation

Dear Ms. Mann:

This letter is to follow up on your conversations with Gene Schisel of ICS Inc. regarding the above referenced encapsulation.

For asbestos encapsulation we recommend applying 1/8 inch PermaTec 3000 industrial floor coating directly over the asbestos concrete. The PermaTec 3000 system is an epoxy based systems with a silica filler providing a non slip surface.

The PermaTec 3000 system is totally non porous, stronger than concrete, and will adhere tenaciously to the concrete, i.e. the concrete will fail before the bond to the surface fails.

The PermaTec 3000 system is the same type system that has been used successfully for several PCB encapsulations across the country.

The price for the PermaTec 3000 product at 1/8 inch is $1.71 per square foot based upon the quantities expected for this project, fob Tulsa, OK.

This price does not include the labor cost which we can provide to you as needed.

I am faxing a technical data sheet for the PermaTec 3000 for your review.

Please call me with any questions.

Very Truly,

Marty Testa

Marty D. Testa
ChemProof Polymers, Inc.

CC: Gene Schisel, CCI, Inc.
MDT/bg

FEC-2233 Coating

Appendix A-8

Johns Manville International
Marrero, Louisiana

April 21, 1998
Job No. 6032-09

Prepared By:

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FEC-GEL

Product Review

1. Product Name

FEC-GEL is a two-component, 100% solids, 2:1 ratio, flexibilized Polysulfide/Epoxy surfacer for filling and repairing "bug" holes in concrete and steel.

2. Manufacturer

Morton International, Inc.
100 North Riverside Plaza
Chicago, Illinois 60606-1598
1-800-257-9596

3. Product Description

Basic Uses: FEC-GEL is a high-performance surfacing compound used in conjunction with our FEC-2000 series flexible epoxy coatings. FEC-GEL fills and seals pores, small holes and honeycombs in concrete and masonary surfaces and can also be used as a cove joint material for transitional points in concrete and steel containment structures.

Limitations: Do not apply when substrate or ambient temperature is below 40°F (4°C) or if temperatures are expected to fall below 40°F (4°C) within 24 hours. Do not apply in rain. Protect from rain until fully cured. Do not apply on frozen or frost covered substrates. Do not apply on water saturated brick or natural stones if freezing conditions are expected prior to full cure.

Color: Beige

Packaging: Standard 3 gallon unit consisting of base and activator nested in 6 gallon pail. Larger units possible, subject to inquiry.

4. Technical Data

FEC-GEL two-component patching compound, based on Morton's LP liquid polysulfide and epoxy polymers, resist the effects of sunlight , rain, snow, ozone, aging, shrinkage, and the daily and seasonal cyclic changes in temperature, even after years of exposure.

Life Expectancy: Normal conditions, 15 - 20 years; severe conditions, 10 years or less.

Typical Properties:

Appearance of Product:	
Part A	Creamy paste/White
Part B	Creamy paste/Off-White
Solids (%)	100
Hardness - Shore D *(ASTM D 2240)*	30-40
Work Life *(100 grams at 75°F)*	75-105 min
Tack-Free	6-8 hours
Recoat	Overnight
Elongation @ Break (%) *(ASTM D 638)*	50-70
Tensile Strength, psi *(ASTM D 638)*	450-550
Mix Ratio	
Part A	2 parts
Part B	1 part
Weight/Gallon:	
Part A	13.1+0.2
Part B	11.2+0.2

5. Installation

Surface Preparation: Clean and remove all dust, dirt, grease, oils, laitance, efflorescence, biological residue, existing paint or coatings, curing compounds or any other contaminants which might affect the bond. A variety of methods can be used. If chemical cleaning agents are used, neutralize and wash down residues completely.

Masonry walls should be properly cured to full load-bearing capacity, laid true, and with joints tooled. For cast-in-place or precasted concrete, remove all form-release agents or curing compounds. High pressure water, with or without abrasives, is recommended. Properly prepared concrete will have an open texture similar to fine grit sandpaper.

Caution: Different and unusual building material, special coatings and/or surface treatments may affect optimum adhesion. In these instances, a field trial is recommended to determine actual adhesion with or without primer. Morton will conduct laboratory testing under simulated conditions on substrate specimens provided.

Temperature Restrictions: Substrate temperature must range between 50°F (10°C) and 110°F (43°C).

Mixing: Thorough blending of the components is essential for maximum performance of FEC-GEL patching compound. Before adding Part A, mix Part B with a slow-speed 1/2" drill (250-300 rpm) with Jiffy mixing paddle. Then add Part A to Part B and mix until the material is completely blended. Minimum mixing time is 6 minutes. Scrape down the sides of the container and mixing paddle periodically during mixing.

Caution: Do not mix base and activator components from one shipment with components from another.

Application: FEC-GEL is supplied in a soft paste consistency which will tool easily with conventional trowel equipment.

Tooling: Tooling is required during the application to ensure full contact and complete penetration into the substrate.

Cleaning: Use xylene, toluene or MEK to remove smears and excess material before it cures, or to clean equipment.

Shelf Life: Six months in original, unopened containers stored at temperatures lower than 80°F (26°C).

Precautions: Personal cleanliness is essential when using this material. Do not smoke or eat with FEC-GEL on your hands. A barrier cream should be used on forearms and hands to remove material from skin. This will also protect your hands from the drying effect of solvents used to clean equipment. The use of gloves is preferred for improved hygiene. Wash skin with an industrial hand cleaner (not the solvent or cleaning fluid used to clean equipment). Any material contacting the skin should be removed at once with a clean, dry cloth before using cleaner. Avoid contact with skin. If contact occurs, remove material on skin with an industrial-type hand cleaner. Prolonged or repeated exposure to FEC-GEL patching compound may cause skin irritation or allergic reactions. Refer to Material Safety Data Sheet (MSDS) for additional information.

6. Availability and Cost

Morton FEC's are available from the manufacturing plant in Moss Point, MS, or warehouse locations in Parkesberg, PA, Chicago, IL and Tustin, CA. Morton FEC-GEL is also available through select stocking distributors in major cities. For the name and number of the nearest Morton representative, contact the Customer Service Center, phone (800) 257-9596. A representative can provide prices or put you in touch with the nearest stocking distributor.

7. Warranty

Products manufactured by Morton International, Inc. are produced to meet our manufacturing and sales specifications and will be free of defects. Users shall rely on their own information and tests to determine suitability of the product for the intended use, and because that use is beyond our control, we accept no responsibility or liability for damages resulting from failure in performance. In cases where our products are found not to conform to our specifications, our liability is limited to replacement, up to original purchase amount, of the product proved to be defective. Morton International, Inc. makes no warranty that the product is merchantable or fit for any particular purpose, nor is there any other warranty, express or implied, except as provided herein.

Recommendations made by us for use of a product are based upon tests believed to be reliable, but the purchaser assumes all risks and liability for results obtained in the handling or in the use of the product, whether alone or in combination with other products. In no case will Morton be liable for incidental or consequential damages.

8. Technical Services

Local Morton representatives are available to provide on-site field service, specification assistance, and use evaluation. For further technical or testing assistance, call the Sealant R&D Technical Service Department, phone (800) 682-8052

Morton Polymer Systems
100 North Riverside Plaza, Chicago, IL 60606-1598 312/807-2345 Fax 312/807-3460

Estimated Probable Costs

Appendix B

Johns Manville International
Marrero, Louisiana

April 21, 1998
Job No. 6032-09

Prepared By:

ERM EnviroClean Southwest, LLC
3501 N. Causeway Blvd., Suite 200
Metairie, Louisiana 70002
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400-76\12586M.XLS

TABLE 1
Estimated Cost
Removal and Replacement
Westbank Asbestos Site
Johns Manville International
Marerro, Louisiana

Item	Estimated Quantity		Estimated Unit Cost	Estimated Cost
Capital Cost Items *				
Building Permit (1)	500	Locations	$13	$6,500
ACM Removal: Labor and Equipment (2)	1,000	Driveways	$1,800	$1,800,000
ACM Transportation and Disposal (3)	15,300	Ton	$160	$2,448,000
Driveway Installation: Labor and Equipment(4)	1,000	Driveways	$850	$850,000
New Reinforced Concrete (5)	1,000	Location	$234	$234,000
Unclassified Soil Fill (6)	7,000	yds^3	$15	$105,000
Mobilization	1	Lump Sum	$5,000	$5,000
Services During Construction	18	Months	$3,400	$61,200
Subtotal, Construction				$5,509,700
			Round To:	$5,510,000
Contingency	$5,510,000	Sum	20%	$1,102,000
Construction Management	$5,510,000	Sum	18%	$992,000
Design and Construction Phase Services	18	Month	$6,500	$117,000
Construction Quality Assurance	18	Month	$20,000	$360,000
Air Monitoring (7)	50	Driveways	$750	$38,000
Project Coord/Hotline/Access (8)	3	Months	$14,400	$43,200
Drainage (9)	200	Driveways	$150	$30,000
Subtotal, Capital				$2,682,200
			Round To:	$2,682,000
Present Value of Maintenance Cost Items over 30 years (10)				
Replacement slab will be replaced in 15 years	1	Replacement	$8,192,000	$1,497,000
Total Estimated Capital and Maintenance Cost, Present Value				$9,689,000

Assumptions:

* All cost estimating calculations are based on a driveway with dimensions of 12ft x 30 ft. Field activities are expected to require 18 months to complete.

(1) Building permits are required for Westwego, Gretna, and Algiers areas. For cost estimating purposes, the City of Gretna fee schedule for permits was used to determine permitting expenses. Permitting fees were based on construction material and labor costs (disposal costs were excluded). Five hundred locations were assumed to require building permits.

(2) ACM removal labor and equipment costs include a field crew of two laborers, a supervisor (50% part-time), a backhoe, and a front-end loader. Field days are estimated at 10 hours with one driveway removed per day.

(3) ACM Disposal volume assumes 500 driveways with a thickness of 0.5 ft, 400 driveways with a thickness of 1.0 ft and 100 driveways with a thickness of 2.0 ft. ACM weight is assumed to be 1.35 tons/yd^3.

(4) Drive way installation labor includes two laborers and a supervisor (50% part time). This estimate assumes one driveway can be installed per day.

(5) Driveway final thickness is assumed to be 4-inches. Approximately 4.5 yd^3 of concrete will be used to replace each driveway. Material costs are estimated to be $234 per location.

(6) Installation of soil backfill is assumed to be necessary at each location. At 500 locations, 2-inches of backfill will be placed. At 400 location, 8-inches of soil backfill will be placed. At 100 locations, 20-inches of soil backfill will be placed.

(7) Air monitoring will be implemented at 25 sites in the initial phase of the project. Based on these results, air monitoring will only be implemented periodically throughout the project. Costs assume an additional 25 sites will be monitored for air emissions during remedial activities.

(8) Project coordinator/hotline/access will be completed by a full-time personnel at the start of the project to address the initial influx of calls for the first three months of the project. Afterward, inquiries and access will be addressed by the assigned project manager.

(9) Drainage is assumed to be affected by driveway installation at 200 driveways. Drainage will be improved by installing 3-inch perforated PVC pipe in a trench 6 to 9-inches deep and backfilled with limestone.

(10) Maintenance costs assume complete overlay replacement at the end of the expected life adjusted to present value based on a 12% discount rate.

400-76\12586M.XLS

TABLE 2
Estimated Cost
Advanced Asphalt Overlays
Westbank Asbestos Site
Johns Manville International
Marerro, Louisiana

Item	Estimated Quantity		Estimated Unit Cost	Estimated Cost
Capital Cost Items *				
Building Permits (1)	500	Locations	$28	$14,000
Site Preparation and Overlay Installation (2)	1,000	Locations	$2,250	$2,250,000
Asphalt Overlay Materials (3)	1,000	Locations	$900	$900,000
ACM Transportation and Disposal (4)	500	Tons	$160	$80,000
Mobilization	1	Lump Sum	$5,000	$5,000
Services During Construction	7	Months	$3,400	$23,800
Subtotal, Construction				$3,272,800
			Round To:	$3,273,000
Contingency	$3,273,000	Sum	20%	$654,600
Construction Management	$3,273,000	Sum	18%	$590,000
Design and Construction Phase Services	7	Months	$6,500	$45,500
Construction Quality Assurance	7	Months	$20,000	$140,000
Air Monitoring (5)	50	Driveways	$750	$37,500
Project Coord/Hotline/Access (6)	3	Months	$14,400	$43,200
Drainage (7)	200	Driveways	$150	$30,000
Subtotal, Capital				$1,540,800
			Round To:	$1,541,000
Present Value of Maintenance Cost Items (30 years) (8)				
Asphalt overlay has an expected life of 10 years	2	Replacement	$4,814,000	$2,050,000
Total Estimated Capital and Monitoring Cost, Present Value				$6,864,000

Assumptions:

* All cost estimating calculations are based on a driveway with dimensions of 12ft x 30 ft. Field activities are expected to require 7 months to complete.

(1) Building permits are required for Westwego, Gretna, and Algiers areas. For cost estimating purposes, the City of Gretna fee schedule for permits was used to determine permitting expenses. Permitting fees were based on construction material and labor costs (disposal costs were excluded). Five hundred locations were assumed to require building permits.

(2) For installation costs, a factor of 2.5 to the material cost was used to estimate the installed cost of the overlay. For each driveway, installation costs are assumed to be $2,250.

(3) Material Costs for asphalt overlay is $2.50/ft^2. Overlay thickness is assumed to be ¼-inch. Cost per driveway is assumed to be $900.00.

(4) ACM disposal cost is based on an assumed average disposal volume of 0.5 yd^3 of loose per property (one-half inch on a 12ft x 30 ft driveway). Density of loose material is assumed to be 1.0 ton/yd^3.

(5) Air monitoring will be implemented at 25 sites in the initial phase of the project. Based on these results, air monitoring will only be implemented periodically throughout the project. Costs assume an additional 25 sites will be monitored for air emissions during remedial activities.

(6) Project coordinator/hotline/access will be completed by a full-time personnel at the start of the project to address the initial influx of calls for the first three months of the project. Afterward, inquiries and access will be addressed by the assigned project manager.

(7) Drainage is assumed to be affected by driveway installation at 200 driveways. Drainage will be improved by installing 3-inch perforated PVC pipe in a trench 6 to 9-inches deep and backfilled with limestone.

(8) Maintenance costs assume complete overlay replacement at the end of the expected life adjusted to present value based on a 12% discount rate.

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TABLE 3
Estimated Cost
Conventional Concrete Overlays
Westbank Asbestos Site
Johns Manville International
Marerro, Louisiana

Item	Estimated Quantity		Estimated Unit Cost	Estimated Cost
Capital Cost Items *				
Building Permits (1)	500	Locations	$10	$5,000
Site Preparation and Overlay Installation (2)	1,000	Locations	$325	$325,000
Concrete Overlay Material (3)	1,000	Locations	$130	$130,000
ACM Transportation and Disposal (4)	500	Tons	$160	$80,000
Mobilization	1	Lump Sum	$5,000	$5,000
Services During Construction	8	Sum	$3,400	$27,200
Subtotal, Construction				$572,200
			Round To:	$572,000
Contingency	$572,000	Sum	20%	$114,400
Construction Management	$572,000	Sum	18%	$103,000
Design and Construction Phase Services	8	Months	$6,500	$52,000
Construction Quality Assurance	8	Months	$20,000	$160,000
Air Monitoring (5)	50	Driveways	$750	$37,500
Project Coord/Hotline/Access (6)	3	Months	$14,400	$43,200
Drainage (7)	200	Driveways	$150	$30,000
Subtotal, Capital				$540,100
			Round To:	$540,000
Present Value of Maintenance Cost Items over 30 years				
Overlay will be replaced once at year 15	1	Replacement	$1,106,000	$202,000
Total Estimated Capital and Monitoring Cost, Present Value				$1,314,000

Assumptions:

* All cost estimating calculations are based on a driveway with dimensions of 12 ft x 30 ft. Field activities are expected to require 8 months to complete.

(1) Building permits are required for Westwego, Gretna, and Algiers areas. For cost estimating purposes, the City of Gretna fee schedule for permits was used to determine permitting expenses. Permitting fees were based on construction material and labor costs (disposal costs were excluded).
Five hundred locations were assumed to require building permits.

(2) For installation costs, a factor of 2.5 to the material cost was used to estimate the installed cost of the overlay. For each driveway, installation costs are assumed to be $325.

(3) ACM disposal cost is based on an assumed average disposal volume of 0.5 yd^3 of loose per property (one-half inch on a 12ft x 30 ft driveway). Density of loose material is assumed to be 1.0 ton/yd^3.

(4) Material Costs for conventional concrete overlay is $52/$yd^3$. Overlay thickness is assumed to be 2-inches and 2.5 yd^3 of material will be used in constructing each driveway. Cost per driveway is assumed to be $130.

(5) Air monitoring will be implemented at 25 sites in the initial phase of the project. Based on these results, air monitoring will only be implemented periodically throughout the project. Costs assume an additional 25 sites will be monitored for air emissions during remedial activities.

(6) Project coordinator/hotline/access will be completed by a full-time personnel at the start of the project to address the initial influx of calls for the first three months of the project. Afterward, inquiries and access will be addressed by the assigned project manager.

(7) Drainage is assumed to be affected by driveway installation at 200 driveways. Drainage will be improved by installing 3-inch perforated PVC pipe in a trench 6 to 9-inches deep and backfilled with limestone.

(8) Maintenance costs assume complete overlay replacement at the end of the expected life adjusted to present value based on a 12% discount rate.

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TABLE 4
Estimated Cost
Concrete Overlay with Fibermesh
Westbank Asbestos Site
Johns Manville International
Marerro, Louisiana

Item	Estimated Quantity		Estimated Unit Cost	Estimated Cost
Capital Cost Items *				
Building Permits (1)	500	Locations	$12	$6,000
Site Preparation and Overlay Installation (2)	1,000	Locations	$365	$365,000
Concrete Overlay with Fibermesh (3)	1,000	Locations	$145	$145,000
ACM Transportation and Disposal (4)	500	Tons	$160	$80,000
Mobilization	1	Lump Sum	$5,000	$5,000
Services During Construction	6.5	Months	$3,400	$22,100
Subtotal, Construction				$623,100
			Round To:	$623,000
Contingency	$623,000	Sum	20%	$124,600
Construction Management	$623,000	Sum	18%	$113,000
Design and Construction Phase Services	6.5	Months	$6,500	$42,250
Construction Quality Assurance	8	Months	$20,000	$160,000
Air Monitoring (5)	50	Driveways	$750	$37,500
Project Coord/Hotline/Access (6)	3	Months	$14,400	$43,200
Drainage (7)	200	Driveways	$150	$30,000
Subtotal, Capital				$550,550
			Round To:	$551,000
Present Value of Maintenance Cost Items over 30 years				
Fibermesh will be replaced once at year 15	1	Replacement	$1,174,000	$214,000
Total Estimated Capital and Monitoring Cost, Present Value				$1,388,000

Assumptions

* All cost estimating calculations are based on a driveway with dimensions of 12 ft x 30 ft. Field activities are expected to require 6.5 months to complete.

(1) Building permits are required for Westwego, Gretna, and Algiers areas. For cost estimating purposes, the City of Gretna fee schedule for permits was used to determine permitting expenses. Permitting fees were based on construction material and labor costs (disposal costs were excluded).
Five hundred locations were assumed to require building permits.

(2) For installation costs, a factor of 2.5 to the material cost was used to estimate the installed cost of the overlay. For each driveway, installation costs are assumed to be $365.

(3) ACM disposal cost is based on an assumed average disposal volume of 0.5 yd^3 of loose per property (one-half inch on a 12ft x 30 ft driveway). Density of loose material is assumed to be 1.0 ton/yd^3.

(4) Material Costs for Fibermesh overlay is $58.00/$yd^3$. Overlay thickness is assumed to be 2-inches and 2.5 yd^3 of material will be used in constructing each driveway. Cost per driveway is assumed to be $145.

(5) Air monitoring will be implemented at 25 sites in the initial phase of the project. Based on these results, air monitoring will only be implemented periodically throughout the project. Costs assume an additional 25 sites will be monitored for air emissions during remedial activities.

(6) Project coordinator/hotline/access will be completed by a full-time personnel at the start of the project to address the initial influx of calls for the first three months of the project. Afterward, inquiries and access will be addressed by the assigned project manager.

(7) Drainage is assumed to be affected by driveway installation at 200 driveways. Drainage will be improved by installing 3-inch perforated PVC pipe in a trench 6 to 9-inches deep and backfilled with limestone.

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TABLE 5
Estimated Cost
Perma Crete
Westbank Asbestos Site
Johns Manville International
Marerro, Louisiana

Item	Estimated Quantity		Estimated Unit Cost	Estimated Cost
Capital Cost Items *				
Building Permits (1)	500	Locations	$12	$6,000
PermaCrete (2)	1,000	Locations	$1,080	$1,080,000
ACM Transportation and Disposal (3)	500	Driveways	$160	$80,000
Mobilization	1	Lump Sum	$5,000	$5,000
Services During Construction	6	Months	$3,400	$20,400
Subtotal, Construction				$1,191,400
			Round To:	$1,191,000
Contingency	$1,191,000	Sum	20%	$238,200
Construction Management	$1,191,000	Sum	18%	$215,000
Design and Construction Phase Services	6	Months	$6,500	$39,000
Construction Quality Assurance	6	Months	$20,000	$120,000
Air Monitoring (4)	50	Driveways	$750	$37,500
Project Coord/Hotline/Access (5)	3	Months	$14,400	$43,200
Subtotal, Capital				$649,700
			Round To:	$650,000
Present Value of Maintenance Cost Items over 30 years (6)				
PermaCrete will be replaced once in 20 years	1	Replacement	$1,841,000	$191,000
Total Estimated Capital and Monitoring Cost, Present Value				$2,032,000

Assumptions

* All cost estimating calculations are based on a driveway with dimensions of 12ft x 30 ft. Field activities are expected to require 6 months to complete.

(1) Building permits are required for Westwego, Gretna, and Algiers areas. For cost estimating purposes, the City of Gretna fee schedule for permits was used to determine permitting expenses. Permitting fees were based on construction material and labor costs (disposal costs were excluded).
Five hundred locations were assumed to require building permits.

(2) ACM disposal cost is based on an assumed average disposal volume of 0.5 yd^3 of loose per property (one-half inch on a 12ft x 30 ft driveway). Density of loose material is assumed to be 1.0 ton/yd^3.

(3) Material and installation costs for PermaCrete is \$3.00/ft^2. Cost per driveway is assumed to be \$1,080.00.

(4) Air monitoring will be implemented at 25 sites in the initial phase of the project. Based on these results, air monitoring will only be implemented periodically throughout the project. Costs assume an additional 25 sites will be monitored for air emissions during remedial activities.

(5) Project coordinator/hotline/access will be completed by a full-time personnel at the start of the project to address the initial influx of calls for the first three months of the project. Afterward, inquiries and access will be addressed by the assigned project manager.

(6) Maintenance costs assume complete overlay replacement at the end of the expected life adjusted to present value based on a 12% discount rate.

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TABLE 6
Estimated Cost
Tech Cote
Westbank Asbestos Site
Johns Manville International
Marerro, Louisiana

Item	Estimated Quantity		Estimated Unit Cost	Estimated Cost
Capital Cost Items *				
Building Permits (1)	500	Locations	$24	$12,000
Site Preparation and Overlay Installation (2)	1,000	Locations	$1,620	$1,620,000
Tech Cote Materials (3)	1,000	Locations	$324	$324,000
ACM Transportation and Disposal (4)	500	Tons	$160	$80,000
Mobilization	1	Lump Sum	$5,000	$5,000
Services During Construction	5	Months	$3,400	$17,000
Subtotal, Construction				$2,058,000
			Round To:	$2,058,000
Contingency	$2,058,000	Sum	20%	$411,600
Construction Management	$2,058,000	Sum	18%	$371,000
Design and Construction Phase Services	5	Months	$6,500	$32,500
Construction Quality Assurance	5	Months	$20,000	$100,000
Air Monitoring (5)	50	Driveways	$750	$37,500
Project Coord/Hotline/Access (6)	3	Months	$14,400	$43,200
Subtotal, Capital				$995,800
			Round To:	$996,000
Present Value of Maintenance Cost Items over 30 years (7)				
Tech Cote will be replaced in years 10 and 20	2	Replacements	$3,054,000	$1,300,000
Total Estimated Capital and Monitoring Cost, Present Value				$4,354,000

Assumptions

* All cost estimating calculations are based on a driveway with dimensions of 12 ft x 30 ft. Field activities are expected to require 5 months to complete.

(1) Building permits are required for Westwego, Gretna, and Algiers areas. For cost estimating purposes, the City of Gretna fee schedule for permits was used to determine permitting expenses. Permitting fees were based on construction material and labor costs (disposal costs were excluded).
Five hundred locations were assumed to require building permits.

(2) For installation costs, a factor of 5.0 to the material cost was used to estimate the installed cost of the overlay. For each driveway, installation costs are assumed to be $1,620.

(3) Material Costs for TechCote coating is $.90/ft^2. Cost per driveway is assumed to be $324.00.

(4) ACM disposal cost is based on an assumed average disposal volume of 0.5 yd^3 of loose per property (one-half inch on a 12ft x 30 ft driveway). Density of loose material is assumed to be 1.0 ton/yd^3.

(5) Air monitoring will be implemented at 25 sites in the initial phase of the project. Based on these results, air monitoring will only be implemented periodically throughout the project. Costs assume an additional 25 sites will be monitored for air emissions during remedial activities.

(6) Project coordinator/hotline/access will be completed by a full-time personnel at the start of the project to address the initial influx of calls for the first three months of the project. Afterward, inquiries and access will be addressed by the assigned project manager.

(7) Maintenance costs assume complete overlay replacement at the end of the expected life adjusted to present value based on a 12% discount rate.

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TABLE 7
Estimated Cost
Polibrid 705
Westbank Asbestos Site
Johns Manville International
Marerro, Louisiana

Item	Estimated Quantity		Estimated Unit Cost	Estimated Cost
Capital Cost Items *				
Building Permits (1)	500	Locations	$24	$12,000
Site Preparation and Overlay Installation (2)	1,000	Locations	$9,000	$9,000,000
Polibrid 705 Materials (3)	1,000	Locations	$1,800	$1,800,000
ACM Transportation and Disposal (4)	500	Tons	$160	$80,000
Mobilization	1	Lump Sum	$5,000	$5,000
Services During Construction	6	Months	$3,400	$20,400
Subtotal, Construction				$10,917,400
			Round To:	$10,917,000
Contingency	$10,917,000	Sum	20%	$2,183,400
Construction Management	$10,917,000	Sum	18%	$1,966,000
Design and Construction Phase Services	5	Months	$6,500	$32,500
Construction Quality Assurance	6	Months	$20,000	$120,000
Air Monitoring (5)	50	Driveways	$750	$37,500
Project Coord/Hotline/Access (6)	3	Months	$14,400	$43,200
Subtotal, Capital				$4,382,600
			Round To:	$4,383,000
Present Value of Maintenance Cost Items over 30 years (7)				
Tech Cote will be replaced in years 10 and 20	2	Replacements	$15,300,000	$11,440,000
Total Estimated Capital and Monitoring Cost, Present Value				$26,740,000

Assumptions

* All cost estimating calculations are based on a driveway with dimensions of 12 ft x 30 ft. Field activities are expected to require 6 months to complete.

(1) Building permits are required for Westwego, Gretna, and Algiers areas. For cost estimating purposes, the City of Gretna fee schedule for permits was used to determine permitting expenses. Permitting fees were based on construction material and labor costs (disposal costs were excluded).
Five hundred locations were assumed to require building permits.

(2) For installation costs, a factor of 5.0 to the material cost was used to estimate the installed cost of the overlay. For each driveway, installation costs are assumed to be $9000.

(3) Material Costs for Polibrid coating is $5.0/ft^2. Cost per driveway is assumed to be $1800.00

(4) ACM disposal cost is based on an assumed average disposal volume of 0.5 yd^3 of loose per property (one-half inch on a 12ft x 30 ft driveway). Density of loose material is assumed to be 1.0 ton/yd^3.

(5) Air monitoring will be implemented at 25 sites in the initial phase of the project. Based on these results, air monitoring will only be implemented periodically throughout the project. Costs assume an additional 25 sites will be monitored for air emissions during remedial activities.

(6) Project coordinator/hotline/access will be completed by a full-time personnel at the start of the project to address the initial influx of calls for the first three months of the project. Afterward, inquiries and access will be addressed by the assigned project manager.

(7) Maintenance costs assume complete overlay replacement at the end of the expected life adjusted to present value based on a 12% discount rate.

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TABLE 8
Estimated Cost
Permatec 3000 "Industrial Coating"
Westbank Asbestos Site
Johns Manville International
Marerro, Louisiana

Item	Estimated Quantity		Estimated Unit Cost	Estimated Cost
Capital Cost Items *				
Building Permits (1)	500	Locations	$28	$14,000
Site Preparation and Overlay Installation (2)	1,000	Locations	$3,080	$3,080,000
Permatec 3000 Materials (3)	1,000	Locations	$620	$620,000
ACM Transportation and Disposal (4)	500	Tons	$160	$80,000
Mobilization	1	Lump Sum	$5,000	$5,000
Services During Construction	6	Months	$3,400	$20,400
Subtotal, Construction				$3,819,400
			Round To:	$3,819,000
Contingency	$3,819,000	Sum	20%	$763,800
Construction Management	$3,819,000	Sum	18%	$688,000
Design and Construction Phase Services	6	Months	$6,500	$39,000
Construction Quality Assurance	6	Months	$20,000	$120,000
Air Monitoring (5)	50	Driveways	$750	$37,500
Project Coord/Hotline/Access (6)	3	Months	$14,400	$43,200
Subtotal, Capital				$1,691,500
			Round To:	$1,692,000
Present Value of Maintenance Cost over 30 years (7)				
PermaTech will be replaced one time in 15 years	1	Replacement	$5,511,000	$1,007,000
Total Estimated Capital and Monitoring Cost, Present Value				$6,518,000

Assumptions

* All cost estimating calculations are based on a driveway with dimensions of 12 ft x 30 ft. Field activities are expected to require 6 months to complete.

(1) Building permits are required for Westwego, Gretna, and Algiers areas. For cost estimating purposes, the City of Gretna fee schedule for permits was used to determine permitting expenses. Permitting fees were based on construction material and labor costs (disposal costs were excluded).
Five hundred locations were assumed to require building permits.

(2) For installation costs, a factor of 5.0 to the material cost was used to estimate the installed cost of the overlay.
For each driveway, installation costs are assumed to be $3,080.

(3) Material Costs for PermaTech coating is $1.71/ft^2. Cost per driveway is assumed to be $620.00

(4) ACM disposal cost is based on an assumed average disposal volume of 0.5 yd^3 of loose per property (one-half inch on a 12ft x 30 ft driveway). Density of loose material is assumed to be 1.0 ton/yd^3.

(5) Air monitoring will be implemented at 25 sites in the initial phase of the project. Based on these results, air monitoring will only be implemented periodically throughout the project. Costs assume an additional 25 sites will be monitored for air emissions during remedial activities.

(6) Project coordinator/hotline/access will be completed by a full-time personnel at the start of the project to address the initial influx of calls for the first three months of the project. Afterward, inquiries and access will be addressed by the assigned project manager.

(7) Maintenance costs assume complete overlay replacement at the end of the expected life adjusted to present value based on a 12% discount rate.

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TABLE 9
Estimated Cost
FEC-2233
Westbank Asbestos Site
Johns Manville International
Marerro, Louisiana

Item	Estimated Quantity		Estimated Unit Cost	Estimated Cost
Capital Cost Items *				
Building Permits (1)	500	Locations	$24	$12,000
Site Preparation and Overlay Installation (2)	1,000	Locations	$1,800	$1,800,000
FEC-2233 Materials (3)	1,000	Locations	$360	$360,000
ACM Transportation and Disposal (4)	500	Tons	$160	$80,000
Mobilization	1	Lump Sum	$5,000	$5,000
Services During Construction	5	Sum	$3,400	$17,000
Subtotal, Construction				$2,274,000
			Round To:	$2,274,000
Contingency	$2,274,000	Sum	20%	$454,800
Construction Management	$2,274,000	Sum	18%	$410,000
Design and Construction Phase Services	5	Months	$6,500	$32,500
Construction Quality Assurance	5	Months	$20,000	$100,000
Air Monitoring (5)	50	Driveways	$750	$37,500
Project Coord/Hotline/Access (6)	3	Months	$14,400	$43,200
Subtotal, Capital				$1,078,000
			Round To:	$1,078,000
Present Value of Maintenance Cost Items over 30 years (7)				
FEC-2233 will be replaced in years 8, 16, and 24	3	Replacements	$3,352,000	$2,122,000
Total Estimated Capital and Monitoring Cost, Present Value				$5,474,000

Assumptions

* All cost estimating calculations are based on a driveway with dimensions of 12 ft x 30 ft. Field activities are expected to require 5 months to complete.

(1) Building permits are required for Westwego, Gretna, and Algiers areas. For cost estimating purposes, the City of Gretna fee schedule for permits was used to determine permitting expenses. Permitting fees were based on construction material and labor costs (disposal costs were excluded).
Five hundred locations were assumed to require building permits.

(2) For installation costs, a factor of 5.0 to the material cost was used to estimate the installed cost of the overlay. For each driveway, installation costs are assumed to be $1,800.

(3) Material Costs for FEC-2233 coating is $1.00/ft^2. Cost per driveway is assumed to be $360.00.

(4) ACM disposal cost is based on an assumed average disposal volume of 0.5 yd^3 of loose per property (one-half inch on a 12ft x 30 ft driveway). Density of loose material is assumed to be 1.0 ton/yd^3.

(5) Air monitoring will be implemented at 25 sites in the initial phase of the project. Based on these results, air monitoring will only be implemented periodically throughout the project. Costs assume an additional 25 sites will be monitored for air emissions during remedial activities.

(6) Project coordinator/hotline/access will be completed by a full-time personnel at the start of the project to address the initial influx of calls for the first three months of the project. Afterward, inquiries and access will be addressed by the assigned project manager.

(7) Maintenance costs assume complete overlay replacement at the end of the expected life adjusted to present value based on a 12% discount rate.